FAUNAL ANALYSIS OF THE HISTORIC COMPONENT AT HEALY LAKE VILLAGE SITE, INTERIOR ALASKA

By

Hilary A. Hilmer, B.A.

A Thesis Submitted in Partial Fulfillment of the Requirements

for the Degree of

Masters of Arts

in

Anthropology

University of Alaska Fairbanks

August 2019

APPROVED:

Ben Potter, Committee Co-Chair
Jamie Clark, Committee Co-Chair
Joshua Reuther, Committee Member
Ben Potter, Chair
Department of Anthropology
Todd Sherman, Dean
College of Liberal Arts
Michael Castellini, *Dean of the Graduate School*

Abstract

The historic period in Interior Alaska was a dynamic time that led to many cultural changes for Native Alaskan communities across the state. Starting in the early 1700s, Russian and Euroamerican explorers began interacting with Native Alaskan groups living on the coast and by the end of the 18th century - early 19th century, Interior Alaskan groups were being directly affected. Due to western influences, Native groups, such as the Upper Tanana Athabascans, began to rely on a cash economy, causing them to settle to year-round villages, trade with the Euroamericans for non-local goods (i.e., flour, guns, buttons, glass, and nails), and work on construction projects in order to provide for their families. All of these changes appeared to cause a division between the traditional way of life and the new Euroamerican way of living.

Healy Lake Village site (XBD-00020) is a multi-component site with occupations spanning the terminal Pleistocene into the Holocene. It is located approximately 100 miles southeast of present day Fairbanks on the shores of Healy Lake in the Upper Tanana Athabascan territory. The village was a summer fishing camp until ~A.D. 1910; it became a year-round village soon after the construction of a trading post at Healy Lake.

The well-preserved faunal remains excavated from the Upper Cultural level (dating to A.D. 1880 – 1946) at Healy Lake Village site provide a significant opportunity to address fundamental questions relating to subarctic hunter-gatherer subsistence economies. This research employs concepts from human behavioral ecology and world-systems theory to address questions relating zooarchaeological patterns in the data in terms of taphonomy, human procurement, and processing decisions, as well as historic period land use strategies and trade practices. In this thesis, I explore the possibility that the residents at Healy Lake Village site were affected by Euroamerican influences, specifically in regards to their subsistence economies. However, the results suggest that hunting practices were not drastically altered. The residents still relied heavily on local game as their primary source of subsistence with minor inclusions of western goods, such as canned meat and flour.

Table of Contents

Abstract iii
Table of Contents v
List of Figures ix
List of Tables xiii
List of Appendices xv
Acknowledgments xvii
Chapter 1 Introduction and Project Overview 1
1.1 Introduction 1
1.2 Research Questions 3
1.3 Research Significance 4
1.4 Organization of this Study 5
Chapter 2 Interior Alaska Background 7
2.1 Environment 7
2.1.1 Geography 7
2.1.2 Current Climate 7
2.1.3 Ecology 8
2.2 Athabascan Culture 9
2.2.1 Territory 9
2.2.2 Language 9
2.2.3 Social Organization 10
2.2.4 Potlatch 11
2.2.5 Seasonal Movement 11
2.2.6 Subsistence Practices 13
2.3 19th and 20th Century Impacts 16
2.3.1 Fur Trading 16
2.3.2 Missionary Influence 17
2.3.3 Gold Rush 19
2.3.4 Other 20th Century Influences 20
2.4 Previous Historic Faunal Research in Interior Alaska 21
2.5 Conclusion 23
Chapter 3 Theoretical Background and Expectations 25
3.1 Theoretical Framework 25

3.1.1 Human Behavior Ecology 25
3.1.2 World-Systems Theory 27
3.2 Ethnographic Records as Analogies 31
3.3 Project Expectations 33
3.3.1 Seasonality 33
3.3.2 Faunal Procurement and Processing 34
3.3.3 Spatial Distribution 36
3.3.4 Euroamerican Interaction 36
Chapter 4 Materials and Methods 39
4.1 Faunal Material 39
4.1.1 Excavation Methods 39
4.1.2 Project Limitations 41
4.1.3 Faunal Material 43
4.2 Zooarchaeological Data Collection Methods 43
4.2.1 Coding System 45
4.3 Quantitative and Analytical Procedures 48
4.3.1 NISP, Normalized NISP, %Normalized NISP 48
4.3.2 MNE 49
4.3.3 MNI 50
4.3.4 MAU, %MAU 50
4.3.5 Density Values 50
4.3.6 Fragmentation 51
4.3.7 Statistical Procedures 51
4.3.8 Utility Indices 52
4.4 Fourier Transform Infrared Spectroscopy 52
4.4.1 Research History 52
4.4.2 Method 54
4.5 Spatial Analysis 55
Chapter 5 Results 57
5.1 Spatial Distribution 57
5.2 Size Class 58
5.2.1 Size Class Spatial Distribution 58
5.3 Species and NISP Values 61

5.3.1 Species Distribution 62
5.4 MNI Values 66
5.5 Taphonomic Variables 66
5.5.1 Burning 67
5.5.1.1 Visual Identification of Burning 67
5.5.1.2 FTIR Results 68
5.5.1.3 Spatial Distribution of Burning 70
5.5.2 Weathering 75
5.5.3 Root Etching 76
5.5.4 Carnivore Damage 76
5.5.5 Cut Marks 78
5.5.6 Other Taphonomic Variables 80
5.6 Density Mediated Attrition 80
5.7 Elemental Data 85
5.7.1 Fragmentation 85
5.7.2 Element Frequency 85
5.7.3 Caribou and Moose Elemental Distribution between Excavation Areas 86
5.7.4 Long Bone Epiphyses versus Long Bone Shaft Distribution 88
5.8 Age Profile 90
5.9 Utility Indices 91
5.10 Results Summary Statement 93
Chapter 6 Discussion and Conclusions 95
6.1 Discussion of Results 95
6.1.1 Taphonomy and Preservation 95
6.1.2 Seasonality 97
6.1.3 Faunal Procurement and Processing 98
6.1.4 Spatial Distribution 101
6.1.5 Euroamerican Interaction 103
6.2 Conclusions 105
References Cited 109
Appendices 119

List of Figures

Figure 1-1. Location map for Healy Lake Village site (Alaska Heritage Resource Survey [AHRS]). 2

Figure 2-1. Diagram of seasonal migrations. 13

Figure 2-2. Location of the trading post (black dot) in proximity to Healy Lake Village site (red dot). 18

Figure 4-1. Healy Lake Village site complete excavation area; modified from Cook (1989). 40

Figure 4-2. Stratigraphic profile at Healy Lake Village site. Re-digitized from Cook (1996). 40

Figure 4-3. Blocks with analyzed faunal material at Healy Lake Village site. 44

Figure 4-4. Blocks from which unidentifiable bones were fully analyzed. 44

Figure 5-1. Distribution map of identified specimens in the Upper Cultural layer. Values are depicted as a number of identified specimens located in a single block. Unidentified fragments are not depicted on this map. 57

Figure 5-2. Distribution map of very small/small/medium mammal remains. Values are depicted as number of identified specimens for each size class category located in a single block. 59

Figure 5-3. Distribution map of large mammal remains. Values are depicted as number of identified specimens for each size class category located in a single block. 60

Figure 5-4. Distribution map of very large remains. Values are depicted as number of identified specimens for each size class category located in a single block. 60

Figure 5-5. Distribution map of bird remains. Values are depicted as number of identified specimens located in a single block. 63

Figure 5-6. Distribution map of caribou remains. Values are depicted as number of identified specimens located in a single block. 64

Figure 5-7. Distribution map of moose remains. Values are depicted as number of identified specimens located in a single block. 64

Figure 5-8. Distribution map of burn code 0. Values are depicted as percent of specimens (identifiable and unidentifiable) assigned to a burn code present in a single block. Values can range from 0% to 100% (or all specimens in the block). 71

Figure 5-9. Distribution map of total burned material. Values are depicted as percent of specimens (identifiable and unidentifiable) classified to a burn code present in a single block. Value can range from 0% (or no specimens in the blocks, gray colored squares) 72

Figure 5-10. . Distribution map of burn code 1. Values are depicted as percent of specimens (identifiable and unidentifiable) classified to a burn code present in a single block. Value can range from 0% (or no specimens in the blocks, gray colored squares) to 100% (or all specimens in the block, red colored squares). 72

Figure 5-11. Distribution map of burn code 2. Values are depicted as percent of specimens (identifiable and unidentifiable) classified to a burn code present in a single block. Value can

range from 0% (or no specimens in the blocks, gray colored squares) to 100% or all specimens in the block, red colored squares). 73

Figure 5-12. Distribution map of burn code 3. Values are depicted as percent of specimens (identifiable and unidentifiable) classified to a burn code present in a single block. Value can range from 0% (or no specimens in the blocks, gray colored squares) to 100% or all specimens in the block, red colored squares). 73

Figure 5-13. Distribution map of burn code 4. Values are depicted as percent of specimens (identifiable and unidentifiable) classified to a burn code present in a single block. Value can range from 0% (or no specimens in the blocks, gray colored squares) to 100% (or all specimens in the block, red colored squares). 74

Figure 5-14. Distribution map of burn code 5. Values are depicted as percent of specimens (identifiable and unidentifiable) classified to a burn code present in a single block. Value can range from 0% (or no specimens in the blocks, gray colored squares) to 100% (or all specimens in the block, red colored squares). 74

Figure 5-15. Distribution map of burn code 6. Values are depicted as percent of specimens (identifiable and unidentifiable) classified to a burn code present in a single block. Value can range from 0% (or no specimens in the blocks, gray colored squares) to 100% (or all specimens in the block, red colored squares). 75

Figure 5-16. Distribution map of carnivore damaged specimens in the Upper Cultural layer. Values are depicted as number of specimens located in a single block. Identifiable and unidentified fragments are both depicted on the map. 77

Figure 5-17. Distribution map of specimens with cut marks in the Upper Cultural layer. Values are depicted as number of specimens located in a single block. Identifiable and unidentified fragments are both depicted on the map. 78

Figure 5-18. Scatterplot of moose bone density values against nNISP for entire site. 82

Figure 5-19. Scatterplot of caribou bone density values against nNISP for entire site. 82

Figure 5-20. Scatterplot of moose bone density values against nNISP for the northern excavation area. 83

Figure 5-21. Scatterplot of moose bone density values against nNISP for the southern excavation area. 83

Figure 5-22. Scatterplot of caribou bone density values against nNISP for the northern excavation area. 84

Figure 5-23. Scatterplot of caribou bone density values against nNISP for the southern excavation area. 84

Figure 5-24. Element frequency graph comparing caribou and moose remains. 86

Figure 5-25. Element frequency graph comparing excavation areas for moose remains. 87

Figure 5-26. Element frequency graph comparing excavation areas for caribou remains. 88

Figure 5-27. Spatial distribution of long bone epiphyseal fragments. Values are depicted as number of identified specimens located in a single block. 89

Figure 5-28. Spatial distribution of long bone shafts fragments. Values are depicted as number of identified specimens located in a single block..... 89

Figure 6-1. Subsistence hunting radii around Healy Lake Village site (Blue represents Dall sheep territory, red represents caribou, and green shows moose territory)..... 100

List of Tables

Table 3-1. Friesen's (2013) world-systems model with archaeological expectations for each zone. 30

Table 3-2. Seasonal species exploitation list created from McKennan's (1959) ethnographic description for the Tanana. 34

Table 3-3. Cut marks on skeletal element by processing behavior. Modified from Binford (1981a: 136-142; Table 4.04). 35

Table 4-1. Revised cultural chronology. Information originated from Cook (1996) and adapted from Younie (2015). 41

Table 4-2. Animal size class classification (modified from Thomas 1969). 46

Table 4-3. Age of fusion for post-cranial bone for Rangifer tarandus (caribou) from Takken Beijersbergen and Hufthammer (2012). 47

Table 4-4. Burned bone coding system (Stiner et al. 1995)..... 48

Table 4-5. Weathering code classification (Behrensmeyer 1978). 48

Table 5-1. Size class distribution for the identifiable faunal material (as a count and as a percentage) for the site and for the two excavation areas separately..... 58

Table 5-2. Species table with NISP, %NISP, MNI, and %MNI values. 61

Table 5-3. Species table with NISP and percent of total in excavation area for the two excavation areas. 65

Table 5-4. Bone surface modification list with count and percentage, including identifiable and unidentifiable remains..... 66

Table 5-5. Burned bone code list (Stiner et al. 1995) with count and percentage for entire Upper Cultural assemblage. 67

Table 5-6. Burned bone code list (Stiner et al. 1995) with count and percentage for unidentified material in the Upper Cultural assemblage. 67

Table 5-7. Burned bone code list (Stiner et al. 1995) with count and percentage for identified material in the Upper Cultural assemblage. 68

Table 5-8. Burned bone code list (Stiner et al. 1995) with count and percentage for bird remains identified in the Upper Cultural assemblage..... 68

Table 5-9. FTIR results for the 34 samples analyzed. Table includes UAMN catalogue number, my specimen number, visual identification, results for the three sampling areas, and interpretation of the results based on Thompson (2013). 69

Table 5-10. Weathering code list with count and percentage. 75

Table 5-11. Root etching list with count and percentage..... 76

Table 5-12. List of species and elements with carnivore damage. 77

Table 5-13. List of species and elements list with cut marks. 79

Table 5-14. List of other taphonomic variables. 80

Table 5-15. Statistical results for the density mediated attrition analysis for the entire site. Statistically significant values are indicated in red. 81

Table 5-16. Statistical results for the density mediated attrition analysis for moose and caribou separated by excavation area. Statistically significant values are indicated in red. 81

Table 5-17. Epiphyseal fusion code list with count and percentage. 90

Table 5-18. Unfused element list for moose and caribou with count and percent of total remains for each species. 90

Table 5-19. Results of utility index analyses for caribou and moose remains. Statistically significant values are indicated in red. 91

Table 5-20. Results of utility index analyses for caribou remains for the two excavation areas. Statistically significant values are indicated in red. 92

Table 5-21. Results of utility index analyses for moose remains for the two excavation areas. Statistically significant values are indicated in red. 93

List of Appendices

Appendix A: List of Western Goods Found at Healy Lake, Adapted from Cook 1989..... 119
Appendix B: Element Portion Coding System (Modified from Stiner 2004) 120
Appendix C: Skeletal Elements Recovered from Healy Lake Village Site for Each Taxa. 122
Appendix D: List of Scan Sites used for the Density Mediated Attrition Analysis 131
Appendix E: Utility Index Analysis Values..... 144

Acknowledgments

I would like to thank my advisory committee members: Dr. Ben Potter, Dr. Jamie Clark, and Dr. Joshua Reuther. I could never have completed this work without your guidance, training, and mentorship.

Second I would like to acknowledge Dr. John Cook and the fellow archaeologists who spent multiple summers excavating Healy Lake Village site back in the 1960s and 1970s. This project would never have been possible without their hard work.

I would like to thank Susan Mentzer for providing me the opportunity to fly to the University of Tübingen in Germany and study FTIR under her supervision.

To the Museum of the North staff, Fawn Carter, Sam Coffman, and especially Scott Shirar, I would like to thank you all for taking time out of your busy days to let me into the range, pulling material for me, and providing great company during the endless hours of data collection.

This project would not have been possible without the generosity of two funding sources who made it possible to travel to Germany to conduct my FTIR analysis: Museum of the North Geist Fund and the ASUAF Travel Grant.

Finally, I would like to thank my family and friends for everything they have done for me. Dick and Linda Hilmer, Alexa Brickett, and Eric Walther, this truly would have never been possible without your support, push, and love. The four of you always believe I can accomplish anything I pursue.

To all of the past and current UAF graduate students, especially Crystal Glassburn, Caitlin Holloway, Holly Smith, Dougless Skinner, Kaitlyn Fuqua, Kate Mulliken, Hanna Stewart, Joe Keeney, Gerad Smith, Rob Bowman, Liz Bowman, Nick Schmuck, Beth Mikow, Evie Combs, Holly McKinney, Tom Allen, Brooks Lawler, Keenan Britt, Kevin Sippel, and Casey Jobe, thank you all for the endless guidance, keeping me calm during all of the stressful moments, and distractions when needed. I would also like to thank Crystal and Caitlin for being my travel partners who provided me the necessary escape from the Alaskan winters and a break from thesis work. Keenan Britt and Kevin Sippel, thank you for being amazing office mates. Holly Smith, I truly appreciate you for being my thesis buddy, editing my chapters along the way, and pushing me to finish.

Allie and Mark Dewey, I truly appreciate you both for opening your doors to me when I needed a place to live during field seasons as well as most Sundays for well needed venting sessions over cheese and crackers.

Mary Ann Sweeney and Molly Proue, thank you for all of the well needed hugs and nacho dates when school seemed to be crashing down.

Finally, Taylor Morgan, Melina Tej Chaouch, Jenny Riley, and Meddie Reifsteck, thank you so much for allowing me to complain over the past four years and be my support group outside the anthropology department and the field of archaeology.

Chapter 1 Introduction and Project Overview

1.1 Introduction

From hunter-gatherers to multi-national empires, communities across the world have had close relations with animals as food sources, trading currency, pets, modes of transportation, and as farming equipment, as well as gods, spirits, and other religious figures (Reitz and Wing 2008). Zooarchaeological research is an essential avenue for examining human-environmental interactions through the study of animal remains and generally has two research goals: "reconstruction of hominid subsistence patterns, and reconstruction of paleoecological conditions (Hess and Wapnish 1985; Klein and Cruz-Uribe 1984)" (Lyman 1994a: 2). The field originated from a combined biological and anthropological background and has expanded to explore everything from environmental reconstruction to residential patterns, nutrition, social identity, and economies. Depending on the region of study, various research objectives are more prominent (Reitz and Wing 2008). By studying the faunal remains from Interior Alaskan sites, researchers can gain a better understanding of how indigenous communities utilized animal resources to survive and thrive in subarctic conditions.

The goal for this research is to study the interactions between the inhabitants of an Upper Tanana Athabascan village in the Tanana Valley region of Interior Alaska and their local, and possible nonlocal, resources. The Upper Tanana River Valley is located between two ecoregions that have provided Native Alaskan communities with an abundance of resources since the Late Pleistocene (14,000 – 12,000 cal BP) (Shinkwin and Chase 1984). Healy Lake is one of the numerous lakes in this area of Interior Alaska. The Village site itself is situated on a peninsula that projects into Healy Lake along the northeast shoreline (Cook 1989; Younie 2015). The village has been occupied for the majority of the past 11,000 years due to its close proximity to Healy Lake and River that provided readily available resources. This thesis is concentrated on the most recent component at the site, the Upper Cultural layer, which has been dated to A.D. 1880 – 1946 (Cook 1989; Haynes and Simeone 2007). For the first ~30 years of this occupation, the Healy Lake residents moved seasonally on the landscape and used the lakeshore as their summer fishing camp. After around A.D. 1910, the village became a year-round settlement due to the construction of a Euroamerican trading post nearby; the site was subsequently abandoned in approximately A.D. 1946 (Haynes and Simeone 2007). The lake was not occupied again until

~A.D. 1980 with the formation of the current Healy Lake Village which is located about one mile down the lake shoreline (Haynes and Simeone 2007).

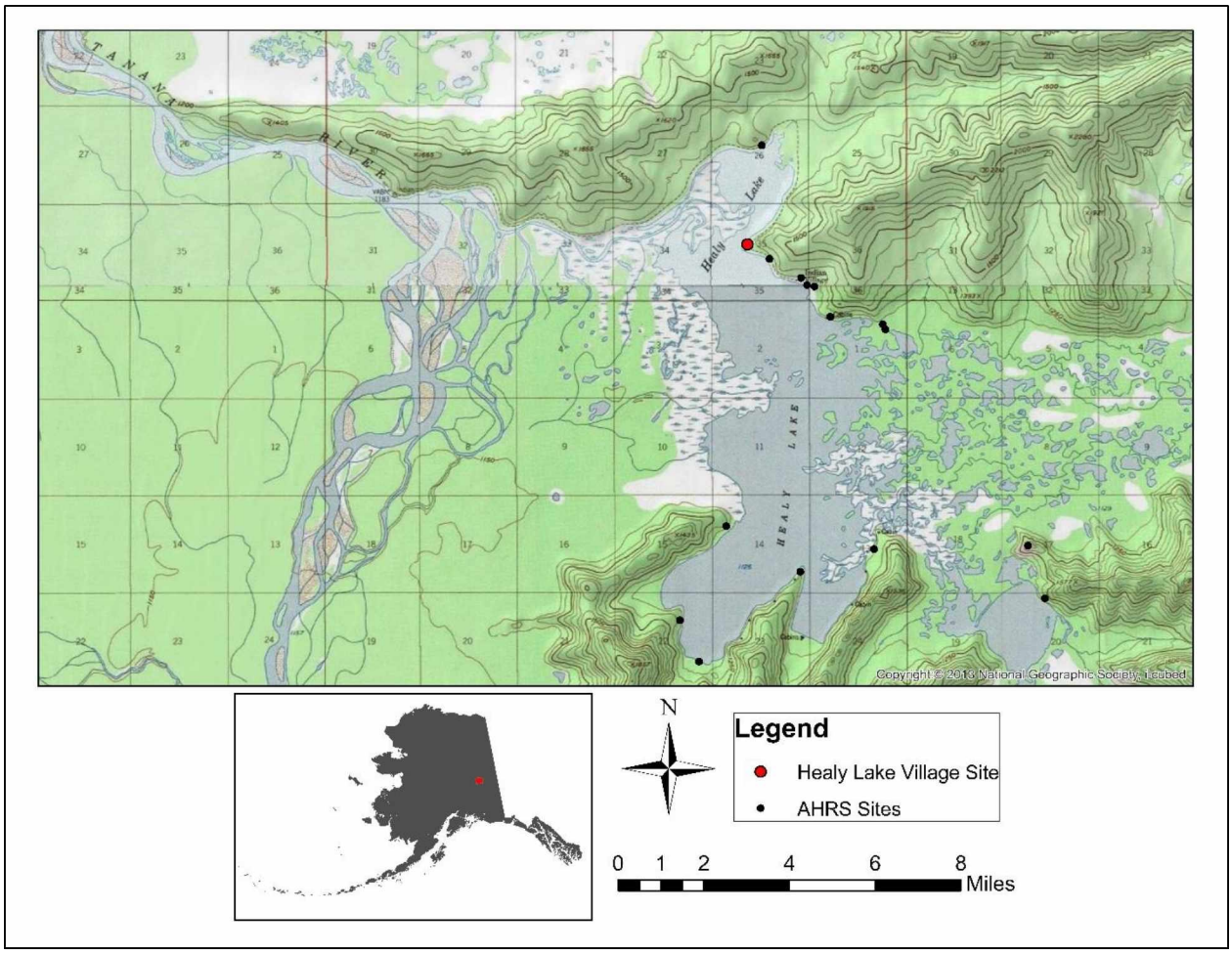

Figure 1-1. Location map for Healy Lake Village site (Alaska Heritage Resource Survey [AHRS]).

This thesis will primarily focus on food sources and subsistence practices, but it will also touch on how animal products were being exploited within the larger economic system between Native Alaskan groups and the Euroamericans. Most of our knowledge relating to Native Alaskan subsistence practices dating to the end of the 18th and early 19th century originates from ethnographies written by Euroamerican anthropologists and explorers, which can be biased and lead to faulty interpretations. This analysis will examine the historic component faunal remains from the Healy Lake Village site in order to provide much needed insight on Native food sources during a dynamic period in Alaskan history when there was a shift away from traditional lifeways and a movement towards a cash economy. A majority of the other zooarchaeological

projects that have studied this time period in Interior Alaska focus their attention on bone tools or the subsistence practices of Euroamerican fur traders, gold miners, and explorers (e.g., Haggar 2008; Le Blanc 1984; Whitney 2009).

1.2 Research Questions

This research has three primary objectives: (1) to identify, quantify, and spatially analyze the faunal remains; (2) to explain patterns in the zooarchaeological data in terms of taphonomy, human procurement and processing decisions; and (3) to situate the Healy Lake Village site within regional models of historic land use and trade patterns. Several research questions were developed to address these objectives; each will be described in more detail later in this thesis:

- *Seasonality:* Are there seasonal indicators in the assemblage? What season(s) was the Healy Lake Village site occupied? Is there evidence of continued seasonal migrations after Euroamerican contact?
- *Faunal Procurement and Processing:* What animal resources were exploited at the Healy Lake Village site? Do the procurement strategies support or contradict regional models described by other researchers? What types of processing occurred at the Healy Lake Village site (i.e., grease rendering, marrow extraction, meat drying, etc.)?
- *Spatial Distribution:* The site consists of two separate excavation areas: northern and southern. Are there different faunal distributions between the excavation areas? Were the excavation areas affected by different taphonomic variables? Can distinct activity zones be identified between the excavation areas?
- *Euroamerican Interaction:* Is there evidence that the people of Healy Lake were trading hunted meat with the Euroamerican community? Moreover, to what degree was the Healy Lake community trading with the settler population?

Prior to answering these questions, the degree of faunal preservation and taphonomic alteration in the assemblage must be evaluated. First, was the collection impacted by density mediated attrition? Second, since Cook (1989) proposed that the excavation area was a modern dog yard, how much of the assemblage has been altered by the presence of dogs? Finally, what other taphonomic factors affected the site (root etching, weathering, etc.)?

1.3 Research Significance

This thesis provides new insights into Native Alaskan subsistence practices during the historic period. The void in information on subsistence during this period is caused by different variables, some of which include poor preservation of archaeological faunal material, biased interpretations from using the ethnographic record to make analogies, and lack of zooarchaeological studies for the historic period.

Bone preservation is highly variable between sites and between occupation periods at a single site. The survivorship of faunal remains depends on environmental factors such as soil acidity, degree of weathering, cryoturbation, and bioturbation, in addition to numerous human made decisions such as the degree of burning, trampling, and processing practices (Reitz and Wing 2008). The faunal remains excavated from the Healy Lake Village site are exceptionally well-preserved and can provide insight on Native hunting strategies, processing practices, and economic trading behavior.

Ethnographies provide incredible detail on Native Alaskan lifeways, ranging from taboos, stories, hunting practices, clothing, ceremonies, marriages, and social structures. However, researchers can over-rely on these sources when developing archaeological interpretations. The ethnographic record should be used as a tool to make analogies to the archaeological record and not as a direct explanation. Though they do provide detailed descriptions of many aspects of life, ethnographers often focused on traditional ways of life and left out details regarding Euroamerican cultural contact, particularly regarding hunting with guns and how much trade for Western goods occurred. This project will use the ethnographic record as a starting point in developing interpretations, but the majority of the conclusions will be drawn from the zooarchaeological record.

The majority of historic period faunal studies that have been conducted on Interior Alaskan archaeological assemblages generally focus on Euroamerican subsistence practices (Haggar 2008; Whitney 2009) or Native Alaskan bone tool types (Le Blanc 1984; Shinkwin 1979). These types of studies then dictate excavation procedures and protocols, in addition to what information is collected during analysis. In the early 1900s, archaeologists focused their attention on tool technology and how technology changed over time. This led to the discard of faunal remains from archaeological sites and an over-emphasis on stone tool types and lithic reduction. When bones were collected and analyzed, they were often in the form of worked tools.

Healy Lake provides a unique opportunity to study faunal remains from a historic Athabascan village in order to address questions relating to human-environmental interactions.

1.4 Organization of this Study

In order to address the previously outlined research questions, this thesis has been divided into six chapters. Chapter 2 is divided into four main sections. The first section dives into the environmental setting of Interior Alaska. The second provides a brief overview of historic Athabascan ways of life in the region. The third describes the main external impacts on their culture during the 19th and 20th century; finally, the fourth provides an overview of other zooarchaeological studies dating to this time period. Chapter 3 discusses the two theoretical frameworks used in this research, the limitations of using ethnographic records, and the research questions. I used Human Behavior Ecology (HBE) as the first theoretical framework to explore behavioral choices regarding subsistence patterns in reference to prey choice, transportation decisions, and risk management. The second theoretical framework is the World-Systems Theory (WST), which originated in the field of Sociology in the 1970s (Wallerstein 2004). WST is now being applied to archaeology as a historic frame of reference that explores core-periphery relationships which opened "new markets for manufactured goods and to gain access to a global pool of exploitable labor and raw materials" (Crowell 1997: 7). Chapter 4 describes the excavation procedures, the limitations of the collection, and the faunal materials analyzed. This chapter also outlines the methods of zooarchaeological data collection and analytical procedures. Chapter 5 presents the results obtained from these analyses and provides a brief discussion of what the results mean. The chapter starts by describing the general distribution of the faunal remains before narrowing to species level data, taphonomic variables that affected the Upper Cultural material at Healy Lake Village site, and, finally, the elemental data. The final chapter of this thesis contextualizes the results and applies them to my research questions, places the historic component at Healy Lake Village site within regional models of historic land use and trade patterns, and discusses avenues for future work.

Chapter 2 Interior Alaska Background

Interior Alaska is a term that refers to the area that extends from the northern slopes of the Brooks Range down to the southern slopes of the Alaska Range, from the Canadian border to Alaska's lower Middle Yukon River (Gardner 1984). This area has been nearly continuously occupied since people migrated into the region via the Bering Land Bridge that connected Alaska to Russia (Pedersen et al. 2016; Potter et al. 2017). The Bering Land Bridge was open by 21,000 cal BP, but the available data suggests that people did not access Interior Alaska until ~14,700 cal BP (Dixon 2013; Potter 2008). Interior Alaskan prehistory has been divided into four time periods: Late Pleistocene (14,000 – 12,000 cal BP), Early Holocene (12,000 – 6,000 cal BP), Mid Holocene period (6,000 – 1,000 cal BP), and the Late Holocene period (<1,000 cal BP); (Potter 2008). The historic component of the Healy Lake Village site (A.D. 1880 – A.D. 1946) falls within the Late Holocene Period.

2.1 Environment

2.1.1 Geography

Healy Lake is located in the Upper Tanana Valley of Interior Alaska. The Tanana River Valley encompasses two distinct ecotones, the Northway-Tanana lowlands, with its widespread river systems, and the higher elevation Yukon-Tanana uplands (Cook 1969; Wahrhaftig 1965). The lowlands consist of "three small basins, separated by screens of low rolling hills" (Wahrhaftig 1965: 24). On the other hand, "rounded even-topped ridges with gentle side slopes" and flat-topped spurs characterize the Yukon-Tanana uplands (Wahrhaftig 1965: 24). There are no modern glaciers in either the upland or lowland zones, and both have discontinuous permafrost (Haynes and Simeone 2007; Wahrhaftig 1965).

2.1.2 Current Climate

The Upper Tanana region is located in a continental climate zone that experiences dynamic changes between the short hot summers and the long cold winters (Ager 1972; Anderson 1975; Haynes and Simeone 2007). During the summer months (June through August) the mean temperature is 65°F with the sun above the horizon for 18 to 21 hours a day (Haynes and Simeone 2007). In the winter (December through March) the average temperature is -22°F, but records exceed -60°F (Ager 1972; Haynes and Simeone 2007). Starting in November, the sun is visible above the horizon for 4 to 10 hours a day until March (Haynes and Simeone 2007). The

Upper Tanana region receives on average 12 inches of precipitation each year, with summer rain occurring primarily in August and snowfall occurring throughout the winter months (Ager 1972; Haynes and Simeone 2007). Ice begins to form on the rivers and lakes in October and breaks up in early May (Haynes and Simeone 2007).

2.1.3 Ecology

During the occupation of Healy Lake Village site, the vegetation in the lowlands and uplands was similar to vegetation today and can be divided between two different categories: Northern Boreal Forest and Alpine Tundra (Ager 1972; Anderson 1975; Haynes and Simeone 2007) The timberline, at an altitude of approximately 2500 to 3000 feet, divides these two vegetation zones with a gradient from forest to shrubby vegetation, and finally to alpine tundra (Ager 1972). The Boreal Forest is home to white spruce (*Picea glauca*), black spruce (*Picean mariana*), paper birch (*Betula papyrifera*), aspen (*Populus tremuloides*), balsam poplar (*P. balsamifera*), willows (*Salix* spp.), white birch (*Betula resinifera*), and shrub birch (*Betula glandulosa*) (Ager 1972; Anderson 1975). The Alpine Tundra consists of dwarf birch (*Betula nana*), cottongrass (*Eriophorum* ssp.), willows (*Salix* spp.), and a variety of lichens, sedges, and berry bushes (Ager 1972). The shrubby vegetation that grows at the gradient between the forest and the tundra is "dominated by alder (*Alnus crispa and Alnus incana*), willows (*Salix* spp.), dwarf birch (*Betula nana*) and other shrubs" (Ager 1972: 7).

By locating their camp between these two very different environmental regions, the inhabitants of Healy Lake had the opportunity to exploit a wide variety of resources, from fish living in the shallow waters of the lake and rivers, to Dall sheep (*Ovis dalli*) living on the rocky slopes of the surrounding mountains (Cook 1969; McKennan 1959). The mammals that inhabit the area today include moose (*Alces alces*), caribou (*Rangifer tarandus*), black bear (*Ursus americanus*), brown bear (*Ursus arctos*), lynx (*Lynx Canadensis*), grey wolf (*Canis lupis*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), wolverine (*Gulo gulo*), North American beaver (*Castor canadensis*), North American porcupine (*Erethizon epixanthum*), snowshoe hare (*Lepus americanus*), muskrat (*Ondatra zibethicus*), and other small mammals (Chester 2016). The birds in the area are generally migratory birds, such as swans, geese, and ducks, but there are also non-migratory ptarmigans (*Lagopus* spp.) and spruce grouse (*Falcipennis Canadensis*) (Chester 2016). The fish that were exploited in the Upper Tanana region and specifically at Healy Lake include arctic grayling (*Thymallus arcticus*), whitefish (*Coregonus* spp.), northern pike (*Esox*

lucius), and other fresh-water fish species (Haynes and Simeone 2007). Many ethnographers use the presence of salmon as a way to separate Upper Tanana Athabaskans, who do not have salmon available, and those who do, in the Lower and Middle Tanana (Andrews 1975; Haynes and Simeone 2007; McKennan 1959). This distinction does not mean that the Upper Tanana Athabascans did not have salmon in their diet, but that they likely would have to trade with other bands for the resource (Haynes and Simeone 2007).

2.2 Athabascan Culture

2.2.1 Territory

The Upper Tanana Athabascan territory is located approximately 100 miles southeast of present-day Fairbanks and encompasses the headwaters of the Tanana River in Alaska and a portion of the headwaters of the White River, which extends over the Canadian border (Haynes and Simeone 2007; McKennan 1959). Their territory has natural boundaries to the south and the north. The southern boundary consists of the Alaska Range and the Wrangell Mountains, which geographically delineates the Upper Tanana territory with their neighboring groups, the Dena'ina and the Ahtna (McKennan 1959, 1981). The northern boundary is formed from the "rugged mountains of the Yukon-Tanana uplands" that extend from the headwaters of the Tolovana River to the east and Mount Harper at the head of Healy River to the west (McKennan 1981: 565). This boundary separated the territory of the Upper Tanana from that of their northern neighbors, the Kutchin and the Han. The eastern boundary extends to the Middle Fork River in the upper tributaries of Fortymile River and the headwaters of the Ladue River (McKennan 1981). The area is dotted with small lakes and wetlands as well as a labyrinth of rivers and creeks that feed into the Tanana River, which bisects the region (Haynes and Simeone 2007).

2.2.2 Language

The Northern Athabascan language family comprises of 23 different languages (Haynes and Simeone 2007). In the Upper Tanana region, two different Athabascan languages were spoken, Upper Tanana and Tanacross (Haynes and Simeone 2007; McKennan 1981). People at Healy Lake, Dot Lake, and Tanacross spoke Tanacross, whereas the Tetlin and Northway bands spoke Upper Tanana (Haynes and Simeone 2007). Though these languages are classified as being distinct, they share similarities with the neighboring Athabascan groups, which allowed them to easily converse with one another (Haynes and Simeone 2007).

> "The grouping of Indian bands treated here under the name Tanana is to a certain extent an arbitrary one. The Athabaskans on the Tanana and Yukon rivers, from the Tutchone to the Ingalik, do not fall easily into a number of discrete cultural or linguistic blocks; but rather, they constitute a continuum of local bands who respective microcultures and dialects differ only slightly from those of their immediate neighbors." (McKennan 1981: 563)

2.2.3 Social Organization

Each band contained two or more families and were led by a "rich man" or chief (Haynes and Simeone 2007; McKennan 1981; Vitt 1971). The non-Native community introduced the term 'chief' at the end of the 19th century (Haynes and Simeone 2007), but for consistency in this thesis, I will use the term 'chief'. The chief is characterized as being a wealthy and wise male in the band (Haynes and Simeone 2007; McKennan 1981). Chieftainship was passed down within the family but did not have any particular rule of inheritance. For example, a father could pass the chieftainship to any of his sons, a maternal nephew or a son-in-law (McKennan 1981).

As for family organization, men and women were not seen as being the property of one another or as romantic partners, but as working units which show "mutual regard for each other and real affection for their children" (McKennan 1959: 116). In general, the social organization for the Upper Tanana has been classified as being an exogamous matrilineal descent group (Haynes and Simeone 2007; McKennan 1981). Partners married outside of their specific social unit, and women tend to own the majority of the belongings (McKennan 1959). The elderly of the group were "treated with respect and kindness" (McKennan 1981). Once they passed away, the bodies were generally cremated, and a potlatch was held in honor of the individual (McKennan 1981). The children were taught at an early age to perform gender related tasks. The girls were taught to sew and to tan skins by their mothers, and the boys started accompanying their fathers on hunting trips as young as five years old (McKennan 1959).

Another central aspect of the social organization for the Upper Tanana families was that men pair up with a hunting partner (McKennan 1981). These partners could be cross cousins, bother-in-laws, or brothers (McKennan 1981; Vitt 1971). This partnership was strictly for economic purposes (Haynes and Simeone 2007; Vitt 1971). When hunting, the partner received the best parts of the animals, and "in times of starvation, a man was expected to give half of his

game, no matter how small, to his partner – even if it caused extreme starvation to his own family" (Vitt 1971: 109).

2.2.4 Potlatch

A potlatch was the primary social gathering or event for the Upper Tanana bands (Haynes and Simeone 2007; McKennan 1981). A potlatch was a "formal and public distribution of gifts to cross-relatives" as a way to "mark or commemorate an event in the life of another person" (McKennan 1981: 577). Potlatches were held for several different reasons, including a boy's first kill, the favorite daughter collecting her first berries, as payment for an offense (murder, injury, fatal accident) given to the offended party by the offender, remarriage after a death, and for a death (Haynes and Simeone 2007; McKennan 1981). It took several months to a year for a clan to organize a potlatch since they needed to compile enough food, blankets and other goods. Each household in the village was expected to clear space to host three or four guests. Messengers, who were supposed to "adopt a pleading attitude," then formally delivered invitations to the guests, who were supposed to "look reluctant to accept" (McKennan 1981: 579). When it was time for the guests to arrive to the host village, they announced their arrival by creating a smoke trail and were welcomed with drums, songs, dances, and rifle shots. Once all the guests had arrived, the feasting could begin. The guests were grouped according to clan and the guest of honor "receives a basin or basket of food, and it is their privilege to 'give it away' to share it with the people seated near them" (McKennan 1981: 579). During the meals, people sang, gave speeches and thanked the host for their generosity. Potlatches could continue for several days, and when they were over, the remaining food was distributed among the guests. After, the host strips himself of his procession and spends two-30 day periods at home or in isolation to avoid bad luck. During this time he must refrain from "laughing, talking, touching his face, or stretching his legs; eating sparingly, drinking very little and only lukewarm water, taking steambaths to stay clean; and keeping away from the sky, woods, the fire, game animals, and women" (McKennan 1981: 581). One of the last significant potlatches held at Healy Lake Village was in 1927 for Chief Healy's death (Andrews 1980; Simeone 1998).

2.2.5 Seasonal Movement

Until the last 100 years, the Upper Tanana bands would move seasonally across the landscape to obtain resources. In the middle of May, the bands would pack up their spring

caribou hunting camps and relocate to their fishing camps along rivers and lakes (Haynes and Simeone 2007; McKennan 1959). Snow was typically still on the ground, so the groups would utilize toboggans for this movement. Toboggans were made of two boards lashed together and were on average 10-12 feet long and two feet wide. Since the snow was still on the ground, people would also move around their landscape with the aid of snowshoes, which were made of birch branches and babiche, or rawhide, and were often decorated with red ocher once completed (McKennan 1959).

Summer fishing camps dotted the shores of rivers and lakes, such as the Goodpaster and Salcha Rivers, and Healy and Mansfield Lakes (McKennan 1959). At the fishing camps, communities would build cylindrical fish traps and large dip nets at weirs across the stream near the outlets of lakes. Fish weirs were seen as a collective effort and the fish caught would be divided up amongst the participating families. If the streams were small, the band would then divide up into smaller family units and fish independently (McKennan 1981). Canoes, used in the summer to make short trips on the water, were about 12-16 feet long and two feet wide and made from birch bark. Canoes were not ideal for major migrations since only one or two people could fit in the watercraft. Skin boats were utilized for crossing rivers since they could carry heavier loads and up to 12 individuals. These boats averaged 17 feet in length and were about four feet wide (McKennan 1959).

Come late summer, the men would move to the southern boundaries of their territory to the Wrangell Mountains and the Alaska Range to hunt Dall sheep (Dall Sheep Species Profile, Alaska Department of Fish and Game n.d.; Haynes and Simeone 2007). The women would stay close to the fishing camps and run snare lines to catch marmots, ground squirrels, and other small game (McKennan 1981). In the fall, the entire band would move to the communal caribou fences (Haynes and Simeone 2007; McKennan 1981). One fence that was documented in the ethnographic record extended from Lake Mansfield down to Mosquito Fork (McKennan 1981). Other fences were located south of Ketchumstock and at the base of Ladue Hill near Tetlin (Vitt 1971), in addition to dotting the landscape in the Yukon-Tanana uplands (McKennan 1981). Finally, with the first signs of winter, "the regional bands typically divided into smaller local bands and moved to semi-permanent camps where fish and meat had been cached for consumption during the winter months" (Haynes and Simeone 2007: 33).

The Upper Tanana bands were also documented to use dogs to help transport belongings during these migrations. They would make caribou skin packs that would be strapped to the backs of the animal (McKennan 1959). Gear would be carried in bags that would be attached to the individual with the aid of tumplines and breast straps (McKennan 1959).

Initially, Healy Lake was occupied during the summer months as a summer fishing camp. It was not until roughly A.D. 1910 that the lake shores became home to a year-round village. Seasonal hunting trips still occurred (i.e., spring caribou hunts, late summer sheep hunts in the mountains, and trips to fall caribou fences) in order to obtain enough meat for the cold, harsh winters (Figure 2-1).

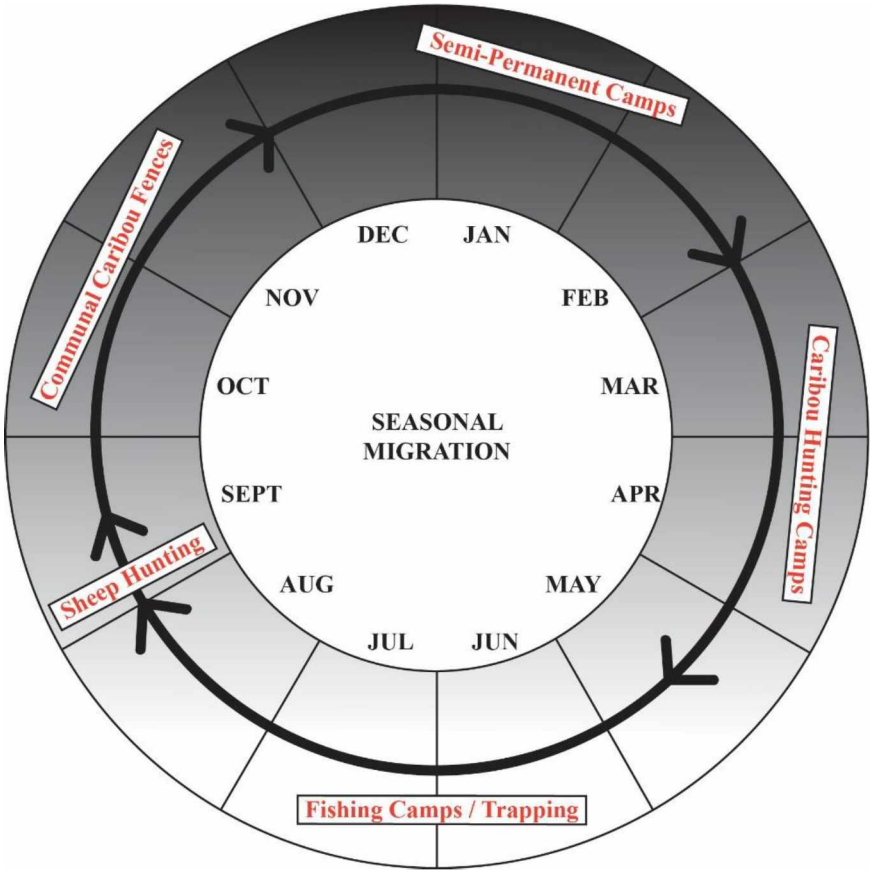

Figure 2-1. Diagram of seasonal migrations.

2.2.6 Subsistence Practices

Big game was a critical resource for the people of Upper Tanana (McKennan 1959, 1969). The main big game exploited in this area were caribou, moose, and Dall sheep. Caribou was the primary food source for people in this region of Alaska. The most efficient manner of

hunting caribou was by herding the animals into caribou fences and corrals that contain numerous snares. Fences were typically 4-5 feet high and were made of brush, branches and small trees tied together. Smaller and weaker animals typically were not targeted unless necessary. After the caribou were killed, the carcasses were dragged to the other side of the fence to be processed and then dried for storage. On average, one family of 4-6 members required a minimum of 10-12 caribou for a year of food, clothing and other items (McKennan 1959).

Moose were also hunted by bow and arrow. Men would find a concealed location along a known and well-traveled moose trail and shoot when the opportunity presented itself. Occasionally moose were also hunted with the aid of moose fences that contained snares, which were typically 5-7 feet tall. On average, hunting a moose required fewer participants than hunting caribou and only 3-4 men went out together. The ribs, brisket, and tenderloins were the choice parts of the animal. Like caribou, meat that was not eaten fresh was either dried or frozen for storage. Marrow from the long bones was also utilized (McKennan 1959).

Caribou and moose meat were generally handled in similar fashions for both cooking and storing. During the summer months, meat was typically cut into long strips and hung to dry; in the winter months, meat was frozen and stored for later. Two types of storage facilities were utilized: aerial and underground caches. The first consists of wooden containers elevated about 10 ft. above the ground. The latter have been described as "having had a pole floor and pole sides; poles were laid across the top and either skin or bark was placed over them; they were then covered with earth, and heavy logs were piled over them to keep off the bears; sometimes a tree was felled over the whole" (McKennan 1959: 32-33). Practically all potions of the animals were consumed; however, the favorite portions consist of the head, legs, ribs, marrow, and the embryo. Fat or bone grease was also commonly obtained through the boiling of meat or bones and then skimming it off the surface. During his 1887 expedition of the Copper, Tanana and Koyukuk Rivers, Henry Allen observed Native communities making pemmican, yet years later no evidence of such activities were witnessed when McKennan was in the region (McKennan 1959).

Dall sheep were hunted during the late summer months when the animals were at their fattest. The hunter could construct a rock blind along a sheep trail to hide behind and shoot the passing animal with bow and arrows. Hunters also utilized natural rock blinds. In this instance, the hunter would lay behind the blind and 'baa' at the passing animal to cause them to stop and

look around, giving the hunter an opportunity to shoot the curious animal with bow and arrows. The final tactic used by men to hunt Dall sheep was to hide along a sheep trail and knife a passing animal behind the shoulders (McKennan 1959). Due to dangerous hunting conditions (i.e., steep slopes, presences of snow and cold temperatures, lack of firewood), sheep were not a vital subsistence resource for the Upper Tanana Athabascans (McKennan 1959; Vitt 1971).

Hunters would imitate a raven call when they spotted a black bear and then shoot the responding animal with bow and arrow (Haynes and Simeone 2007; McKennan 1959). In the winter men would smoke or poke black bears out of their dens and then shoot them as they emerged (McKennan 1959). On the other hand, hunting grizzly bears was slightly different. This activity was only done by the bravest of hunters and involved agitating a grizzly bear with a blunt arrow, then stabbing the animal in the throat with a lance as the bear charged the lone hunter (Haynes and Simeone 2007; McKennan 1959).

Small game, fish and birds were also exploited. Upper Tanana hunters would trap smaller game, such as mink, marten, lynx, weasel, wolverine, beaver, squirrel and hares (Andrews 1980). Fish were caught with large nets, traps and eventually the fish wheel (McKennan 1959, 1969). Birds were knocked out of the sky with bird or blunt arrows.

As mentioned above, most of the traditional tools used for big game hunting included long bows and arrows. Long bows were typically made from birch and ranged from 5-6 feet in length depending on the height of the hunter. The string was made from 2-3 ply twisted sinew of either moose, caribou or bear. The arrow shafts were made of spruce with bone or copper points. Three 5-6 inch feathers, generally eagle, hawk or swan, were attached to the back of the arrow. Arrows were usually two feet long and can be divided into three categories: small game, big game, and compound arrows. Lances or spears, about five feet long, were typically utilized only for grizzly bears and were made from birch with a 7-10 inch bone point on top (McKennan 1959). Guns became readily available after 1847 with the establishment of Fort Yukon (Simeone 1982) and were used for hunting instead of the bow and arrow. During the spring months, it was a common sight to see a man carrying two different types of rifles, a .22 and a larger rifle, for small and large game respectively (McKennan 1959).

2.3 19th and 20th Century Impacts

Beginning as early as the 1700s, Alaskan Native communities were affected by interactions with Russian and Euroamerican cultures. Russian, Spanish, British and American traders were setting up trading posts all along the coast and were slowly expanding up the major river systems. A Russian-American Company trading post was constructed at the mouth of the Copper River in 1788 (Haynes and Simeone 2007). At this early stage, there is no evidence that the Upper Tanana bands had direct contact with non-Native individuals and communities, but they were trading indirectly through intermediaries like the Upper Ahtna (McKennan 1959; Haynes and Simeone 2007). The Upper Ahtna would travel hundreds of miles to acquire a variety of trade goods, such as "leaf tobacco, tea, sugar; a little flour; muzzle loaders and percussion cap firearms, black powder, lead balls, a kind of fuzzy blanket (sometimes used for making clothes), glass beads, and dentalium shells…," (Strong 1976: 154). All of these trade goods would also have been accessible to the Upper Tanana, including Healy Lake, through the trade network with Upper Ahtna Athabascans. The Upper Tanana were also trading furs to the Kluane Lake Tutchone, who acted as middlemen to white traders on the White River (Haynes and Simeone 2007). By the 1890s nearly all Native communities were directly interacting with Euroamericans (Shinkwin et al. 1980).

2.3.1 Fur Trading

The Upper Tanana began trading directly with Euroamerican traders in the late 1880s (Haynes and Simeone 2007; McKennan 1969), though they had been in contact with and were indirectly affected by trading posts since the early 1800s. Men and women both traveled long distances to trade with Russian and English forts at Nulato, the Yukon River, Dawson, Eagle, Forty Mile River, and Circle (Andrews 1975; Haynes and Simeone 2007; McKennan 1969). The Hudson's Bay Company opened trading posts all over the state starting in 1804 with Fort Good Hope in the Mackenzie River (Simeone 1982). After Russia sold Alaska to the United States in 1867, their influence diminished, paving the way for Canadian and American trading companies to dominate the exchange networks and trading posts (Simeone 1982). The Alaskan Commercial Company bought all of the Russian American Company stock, allowing them to monopolize interior trade efforts (Simeone 1982). In 1877, a rival company, Western Fur and Trading Company, opened their first post (Simeone 1982). For the next six years, Native traders took advantage of the competition between the two companies (Haynes and Simeone 2007). Demands

for furs increased and prices inflated, which led to men "spending more time trapping furbearers in the winter months" (Haynes and Simeone 2007: 110; Simeone 1982). After the Western Fur and Trading Company was sold in 1883, the demand for furs stayed consistent, but prices plummeted due to the lack of competition, which caused an economic blow to the Upper Tanana Athabascan communities (Simeone 1982). By the 20th century, trading posts were established in the Upper Tanana region at Tanana Crossing, Tetlin, Nabesna, and Healy Lake (Haynes and Simeone 2007; Simeone 1982). There is little documentation on how frequently the residents at Healy Lake Village visited the trading post located at the mouth of the Healy River, but trade and Western goods were locally available as early as 1907 (Haynes and Simeone 2007; Vitt 1971) (Figure 2-2).

With the formation of these local trading posts in the Upper Tanana territory, Athabascan men lost the incentive to travel long distances to trade unless they could get a better price for their goods (Haynes and Simeone 2007). Firearms replaced traditional hunting technology, metal was used for traps, Natives began wearing Western clothes, and "prestige came to depend on the amount of goods" one owned (McKennan 1959: 129; Haynes and Simeone 2007). Post owners also extended credit or "running tabs" to the traders, which allowed Native families to "bank against hard times, but also tied them in a patron-client relationship to the trader" (Haynes and Simeone 2007: 112).

2.3.2 Missionary Influence

Throughout Alaskan history, there have been multiple waves of missionary activity. Starting in 1794, Russian clergy arrived at Kodiak Island to work with the Shelikhov-Golikov Company. Two years later, Russian clergyman Heiromonk Juvenaly was assigned to the Dena'ina (Tanaina) region and was stationed in Iliamna (Simeone 1982). The second wave of Russian Orthodox clergymen arrived from 1821-1867 with the instruction to train Native clergymen as well as to "render the Native language into written form so that the Sacred Books could be translated and the liturgy be performed in the Native tongue" (Simeone 1982: 55). During this phase, the Russian Orthodox Church expanded to the Yukon, Tanana, Kuskokwim River valleys and the Norton Sound. The last wave of activities for the Russian Orthodox Church occurred between 1867 and 1917, when the Russian Church influence slowly diminished after Alaska was sold to the United States of America (Simeone 1982).

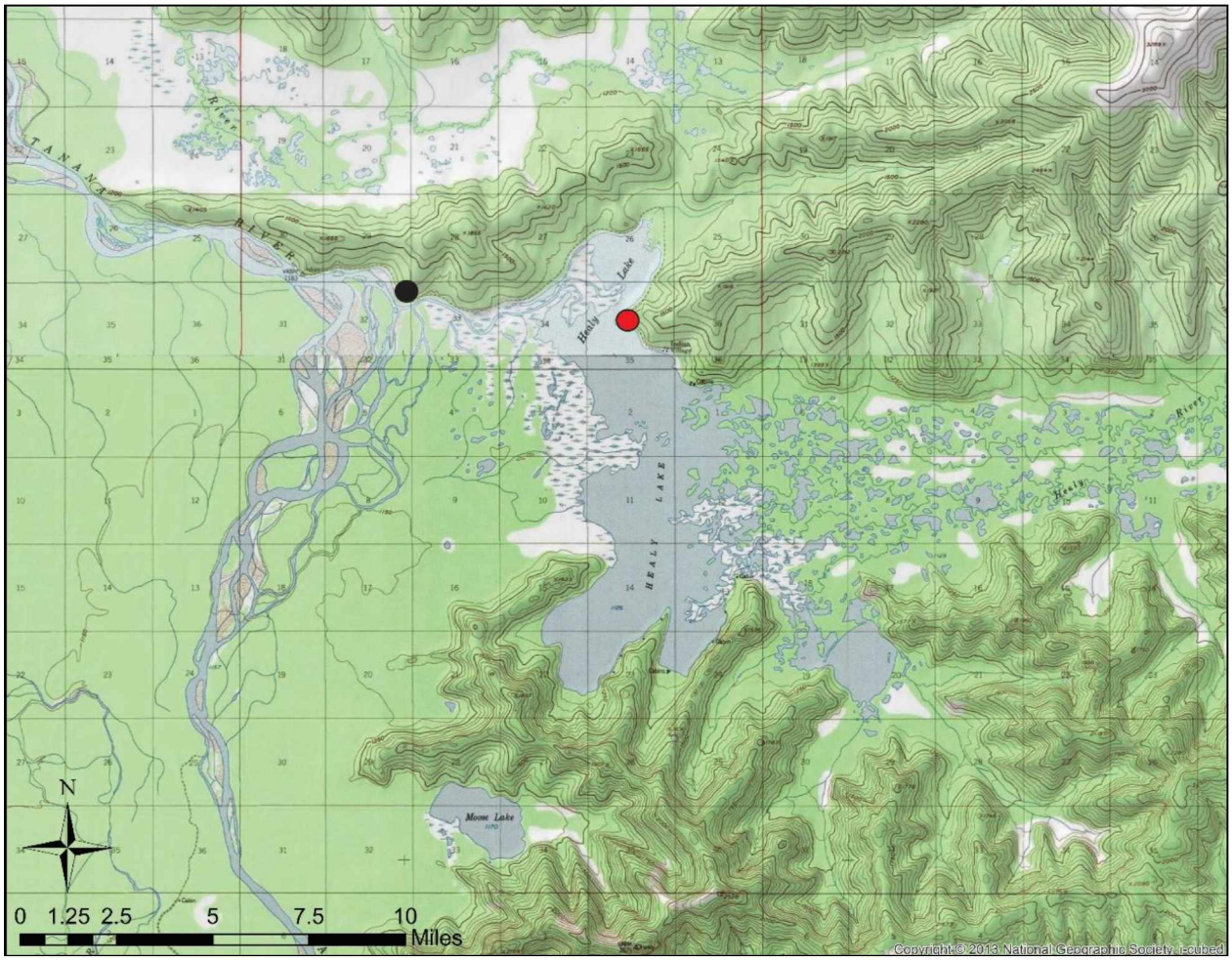

Figure 2-2. Location of the trading post (black dot) in proximity to Healy Lake Village site (red dot).

During this last wave of Russian missionary influence, Christian missionaries opened their doors all over the state and across the Canadian border (Haynes and Simeone 2007). The Anglican Church of Canada began introducing their belief system to the Upper Tanana as early as the 1860s (Simeone 1982). Along the Yukon, Tanana, Koyukuk, and Chandalar Rivers, Episcopal missions were established by Bishop Peter Trimble Rowe starting in 1895 (Haynes and Simeone 2007; Simeone 1982). Rowe later opened the Episcopal Church of Alaska in Fairbanks, which led to missions being constructed in Nenana (1907), Chena Village (1908), Salchaket (1910), Tanacross (1912) and Minto (1929) (Haynes and Simeone 2007; Simeone 1982).

The arrival of missionaries proved to have significant impacts on Athabascan communities. The bishops and priests were sent to Alaska to convert the Native inhabitants away from their shamanistic belief system (Simeone 1982). First, the missionaries had to convert the

Athabascan verbal languages into written languages in order to translate the Bible (Haynes and Simeone 2007). Next, the missions opened schools to provide the Native children with practical skills (Haynes and Simeone 2007; Simeone 1982). Although the schools were meant to 'help' the Native communities, they ended up altering subsistence practices (Haynes and Simeone 2007; McKennan 1959). By the mid-1930s, children were compelled to attend the schools, which prevented them from joining their family members on hunting trips, fish camps, or running trap lines (Haynes and Simeone 2007; McKennan 1959). At this time, the Healy Lake Village petitioned the Bureau of Education for a school to be constructed at Healy Lake; however, E.J. Beck, the bureau's Anchorage-based superintendent, noted that only four school-age children were living at the village and denied their request. There is little documentation regarding whether the children were then required to attend school elsewhere or if they were able to be taught traditionally at home (Haynes and Simeone 2007). With this drastic change to their way of life, the bands became more dependent on trade goods to account for the reduction in hunted and gathered foods, and they also became more sedentary (Haynes and Simeone 2007; McKennan 1959).

2.3.3 Gold Rush

In 1886, the first interior Alaskan gold rush occurred in the northern extent of the Upper Tanana territory, in a tributary on the Fortymile River (Haynes and Simeone 2007). Upon the discovery of gold, hundreds of prospectors flooded the rivers and streams in this area (Haynes and Simeone 2007). After the initial discovery of gold in Alaska, several other gold rushes followed; Circle (1893), the Klondike (1896), Nome (1898), Fairbanks (1902), and the Chisana River (1913) (Haynes and Simeone 2007; Simeone 1982).

Similar to the presence of missionaries, the gold rushes had both positive and negative effects on the Native communities. As more gold was discovered in Alaska, there was a massive influx of white men and women, as well as the formation of mining camps and towns, which ultimately "put a strain on the supply of food held by the Alaska Commercial Company" (Simeone 1982: 71). Since the trading posts had a hard time keeping up with food demands, the miners were forced to hunt local game and fish (Haynes and Simeone 2007; McKennan 1959; Simeone 1982). One geologist who was working in the Upper Tanana territory during the last mining boom in 1914 commented that:

> Game was formerly abundant throughout the region but had now been greatly thinned out in the immediate vicinity of the mines. Elsewhere sheep are plentiful in the more rugged hills and mountains and furnish a valuable food fine quality in this country where provisions are so difficult to obtain. Caribou, while less numerous, are easier to hunt and are fairly plentiful in the rolling country between Beaver Creek and White River. Moose are numerous in the White River valley near the boundary and occasionally range in other parts of the district. Black and grizzly bears are sometimes seen. Both rabbits and ptarmigans have been unusually abundant during the last few years and have been killed in great numbers to supply food for both men and dogs. Some fur-bearing animals, notably fox, lynx, mink, and marten, are trapped each winter (Capps 1914: 197-198; Haynes and Simeone 2007: 109).

Big game in particular were being exhausted to the point that populations were endangered (Haynes and Simeone 2007). In addition to the local food resources being overhunted, trading posts raised prices by 100%, making it extremely difficult for Athabascans to afford food supplies (Simeone 1982). The Native communities turned to market hunting and fishing, selling furs, working in mining camps, and cutting wood for mining camps and trading posts (Haynes and Simeone 2007). However, based on the available ethnographic records, it is unclear how extensively the residence of Healy Lake partook in these activities

2.3.4 Other 20th Century Influences

The turn of the century marked a time of many changes for Native Alaskan groups. Although steam boats were introduced in 1869 by the Hudson's Bay Company, at the beginning of the 20th century, steam boat captains provided work opportunities to Native men (Simeone 1982). Then in 1901, the U.S. Army Signal Corps began construction on the Washington-Alaska Military Cable and Telegraph System (WAMCATS) from Valdez to Fairbanks (Haynes and Simeone 2007). At Tanacross, the telegraph line separated into two different routes, one towards the town of Fairbanks, then to St. Michaels and Nome on the northwest coast of Alaska, and the other to Eagle and across the Canadian border to Dawson and Whitehorse (Haynes and Simeone 2007). This telegraph line connected Alaskan towns and forts with the rest of the country (Simeone 1982). Approximately ten years later, 1,700 head of cattle and sheep were transported

along a trail that later became the Richardson Highway to supply the growing town of Fairbanks with resources (Simeone 1982). Airplanes began landing in the Upper Tanana territory as early as 1922 (Haynes and Simeone 2007). Finally, in 1942, the Alaska Highway underwent construction as a way to support war efforts, which also provided Athabascan men with a source of income (Haynes and Simeone 2007; Hosley 1981). Unfortunately, road construction also brought illness and disease to the Native communities. Healy Lake was especially affected by disease and by 1943, two-thirds of its population had passed away. In addition to these large construction projects, contact with Euroamerican groups also provided Native communities with fish wheels in 1904, outboard motors in 1927, and snow machines in the 1960s (Hosley 1981; Simeone 1982). Direct contact with outside resources, such as education, trading posts with exotic food items, guns, fish wheels, and roads, caused the transition from seasonal movement to a sedentary village lifestyle at Healy Lake by the 1910 (Haynes and Simeone 2007).

2.4 Previous Historic Faunal Research in Interior Alaska

In general, zooarchaeological research in Alaska has focused on the prehistoric record and not on the historic period, since the latter period was documented by trading posts, missions, military expeditions, and ethnographers. In this section, I will discuss eight historic sites that have been explored in interior Alaska using zooarchaeological analyses; four of these are historic Euroamerican camps, and four are Native Alaskan sites.

Jenny Haggar (2008) published a thesis on the analysis of material from two WAMCATS stations, the North Fork telegraph station and Eagle Wireless ratio station. Haggar's goal was to compare commodity flow and national markets at these sites and to identify differences between their subsistence adaptations. Her analysis incorporated animal remains, but the focus was on the other consumer goods present, such as food, beverage, and tobacco containers. The faunal analysis demonstrated that the station workers incorporated local game into their diet, the majority of which was moose and caribou, with lesser amounts of small game and birds.

In 2009, Jim Whitney sought to investigate site-level economy of two Gold Rush period sites, the connection between these sites and the capitalist market, as well as how the two sites differed in their connection to the capitalist market. He concluded that the Grassy Mound Cabin River site was a small-scale mine that was occupied for one season and was dependent on outside commodities, whereas the Marion Creek Mining Complex site was a larger-scale drift

mining camp that was occupied multiple times, was less dependent on commodities and showed an increased consumption of local fauna.

As for Native Alaskan sites, the reports for the Rat Indian Creek (ca. 900 B.C. – A.D. 1840) and Dixthada (A.D. 1816 - 1838) sites only discuss the bone and antler tools; the authors did not discuss subsistence patterns (Le Blanc 1984; Shinkwin 1979). On the other hand, faunal remains from two housepits at Dakah De'nin's village site (Housepits 2 and 9) were analyzed by Shinkwin (1979). Dakah De'nin village site is located on the Copper River and was identified as an Ahtna Athabascan village dating to the protohistoric time period, or the early 19th century (Shinkwin 1979). Housepit 2 revealed an extensive assortment of animal species, including black bear, snowshoe hare, beaver, arctic ground squirrel, lynx, wolf, and porcupine. In contrast, while Housepit 9 yielded snowshoe hare, marmot, shrew-sized animals, and some unidentifiable bones, the assemblage was dominated by salmon bones (30,590 bones). Shinkwin (1979: 88) concluded that:

> The faunal remains reflect the importance of salmon in the diet. The absence of remains of large terrestrial animals is probably related to the practice of butchering in the hills, bringing only the meat to the village. A consideration of the artifact remains indicates that the hunting of large as well as small game animals was being pursued by inhabitants of the site.

Finally, Yesner (1980) conducted zooarchaeological analysis on the remains from the historic component at the Paxon Lake site. The site contains two localities that were identified just east of the lake in 1975. 6,261 bones were found between both localities and consisted of caribou (99% of the assemblage), small mammals, birds, and fish. The author identified two stratigraphically separate faunal distribution patterns at the site: the 'moss/gravel layer' was argued to represent cached meat through the abundance of "caribou ribs and metapodials and relative underrepresentation of skull fragments and vertebrae," and conversely the 'organic layer' was interpreted to signify primary butchery discard based on "greater numbers of caribou skull and mandible fragments as well as vertebrae, and correspondingly fewer long bone sections," (Yesner 1980: 19). Yesner concludes that the faunal assemblage represents a spring migration hunting camp and consists of the remains of primary butchering refuse.

2.5 Conclusion

Healy Lake Village site was occupied during a dynamic time in Alaskan history (A.D.1880 – A.D. 1946). Prior to the arrival of Euroamericans in interior Alaska, Native communities were moving seasonally on the landscape, following subsistence resources. They moved between the alpine tundra environment of the Yukon-Tanana uplands during the spring and fall months to the northern boreal forest landscape of the Northway-Tanana lowlands in the summer and winter months. After Euroamericans started imposing their lifestyle onto the Native communities, most of the Upper Tanana Athabaskans bands made their summer and winter camps into permanent villages. They began participating in a cash economy by buying and selling resources to trading posts, gold miners, and fur trappers. This thesis seeks to explore how (or if) these changes are reflected in the faunal record from the Healy Lake Village site.

Chapter 3 Theoretical Background and Expectations

3.1 Theoretical Framework

3.1.1 Human Behavior Ecology

Human Behavior Ecology (HBE) is a commonly used theoretical framework in archaeology that developed in the 1970s (Garvey and Bettinger 2014; Winterhalder and Smith 2000). HBE, as a hypothetico-deductive strategy, "uses formal models to derive testable hypotheses from either graphical or mathematically explicit models anchored in basic principles of evolution by natural selection" (Winterhalder and Smith 2000: 52) in order to analyze human behavioral diversity (Kelly 2013; Lupo 2007; Winterhalder and Smith 2000). The principal assumption that drives HBE "is that people have been selected to respond flexibly to environmental conditions in ways that enhance their fitness" (Borgerhoff Mulder 2012: 2). HBE became popular for archaeological use due to the ability to reference existing models that aid in making "clear predictions about subsistence change in response to environmental variations" (Garvey and Bettinger 2014: 79; Bird and O'Connel 2006). Initially, this theory was only applied to research questions relating to subsistence practices; however, it is now being used to address questions relating to technological change, social organization, and agriculture (Bird and O'Connell 2006; Lupo 2007).

Optimal foraging models were created in order to assess how a predator might respond to resource availability, primarily food options, on a known landscape (Charnov 1976; MacArthur and Pianka 1966). For this type of analysis to work, there is one overarching assumption that must be accepted: "that animals are in some way optimizing their foraging activities" (Charnov 1976: 129). Prey-choice and patch-choice models are the two main optimal foraging models in use. Both models are based on the concept that food provides needed energy, but that pursuing and handing prey also costs energy (Byers and Ugan 2005). The models can be addressed separately, but for a more comprehensive analysis, can be applied together.

A prey-choice model, or also referred to as the diet breadth model, focuses the attention on what types of food options are being exploited at a given time. There are two general assumptions for this model: (1) "that prey types must be ranked along a single dimension of value, usually energy return rate" as calculated through caloric intake (Smith 1992: 23), and (2) that humans add "resources into their diet in rank order from highest to lowest until the return rate per unit of time is maximized" (Lupo 2007: 147). From these assumptions, the model allows

us to make three general predictions about prey choice (Lupo 2007). The first is that humans primarily go after the highest-ranking prey when encountered since those species are the most beneficial in terms of time and energy spent. The second is that humans will include lower ranking prey into their diet "as a function to the abundance of high-ranked resources and not as a function of their [the lower ranking prey] own abundance" (Lupo 2007: 147). The final prediction is that the rank of the prey determines when the resource is added to the diet and taken out of the diet.

For this project, a prey-choice model will be used when addressing resource use and procurement strategies at the Healy Lake Village site. Vitt (1971) provided a ranked list for animal resources exploited by the Upper Tanana ordered from most important to least: "caribou, moose, fish, lynx, rabbit, bear, porcupine, mountain sheep (Dall sheep), and lastly an assortment of minor animals and bird species" (149). If the inhabitants were exploiting the highest-ranked prey, then the faunal assemblage should be dominated by caribou, moose and fish remains. In 1989, Yesner explored this concept by compiling a sample of 18 late prehistoric, protohistoric, and early historic period sites with faunal collections in Alaska and Canada. The study showed that the majority of faunal assemblages were dominated by caribou remains (93.8-99.3% of the faunal remains identified in the collections). This pattern is consistent with the prey-choice model, in that when the highest ranked resource is abundant, that resource will be pursued before the lower ranking species. However, if caribou herds experienced a population crash, or if their migratory routes changed, then one would predict more moose and other species in the assemblages.

In addition to addressing subsistence use in terms of ranked food sources, a prey-choice model can also be used when evaluating the importance of fur-bearing animals in reference to the increased dependence on a cash economy. The prehistoric faunal assemblages in Interior Alaska reflect a subsistence lifestyle and are dominated by larger game, such as wapiti, bison, moose, sheep, and caribou. Small fur-bearing animals, such as fox, lynx, and marten, make up only a small portion of the assemblages (Potter 2008). If the residents of Healy Lake were purely subsistence hunting, one would expect the faunal assemblage to be dominated by large game with little to no small game present. Conversely, once they started to rely on the cash economy, the value of the smaller animals would increase, making them more desirable to acquire, causing the fur-bearing animals to be more abundant in the assemblage.

On the other hand, the patch-choice model refers to the time and energy spent looking for and acquiring resources on the landscape rather than the particular species being taken (Charnov 1976; MacArthur and Pianka 1966). This model is based on the concept that resources are found in random patches across the landscape and predators move between them in an optimal way, making "decisions as to which patch types it will visit and when it will leave the patch it is presently in … to maximize the net rate of energy intake during a foraging bout" (Charnov 1976: 129-131). Patches are not strictly defined in this model, which can be applied to an individual prey, to a food procurement style (hunting, fishing, or gathering), or a habitat type (Lupo 2007). The patch-choice model can also be paired with the marginal-value theorem, allowing one to predict when to leave a patch by calculating at what point the capture rate for a particular patch drops to the capture rate of the overall habitat, at which time the predator should leave the patch and find another with more resources (Charnov 1976; Lupo 2007).

As previously mentioned, hunter-gatherer groups systematically move around a landscape to obtain resources depending on their abundance. Shinkwin et al. (1980) utilizes a patch-choice model in order to predict where on the landscape mobile hunter-gatherers in Alaska chose to settle into more permanent villages and settlements. She states that settlements dating to the historic period are located in areas that minimize travel distance and time to caribou, moose, sheep, fish, and fowl resources. Shinkwin et al. used the patch-choice model concept of maximizing net energy intake when assessing distance to resources from settlements/villages. She states that nearly all are located near a body of water, while a minimum of three resources could be obtained within a 10 mile radius of the base camp (Shinkwin et al. 1980). All five of the primary resources (fish, fowl, moose, sheep and caribou) are generally available within a 40 mile radius of known settlements. In the end, Shinkwin et al. argues that the location of more permanent villages and settlements was driven by distances to patches in an optimal way (Shinkwin et al. 1980). I will assess if the location of Healy Lake Village site is consistent with Shinkwin et al.'s regional model of historic period Native settlements locations, or if the location was biased by the presence of a trading post at the mouth of the Healy River, causing an over-reliance of western goods.

3.1.2 World-Systems Theory

World-Systems Theory (WST) originated in the social sciences in the 1970s and was developed by Immanuel Wallerstein (Hall and Chase 1993; Wallerstein 2004). Wallerstein

(2004) believes that the modern world-systems developed in the 18th century from the need for constant technological change and a constant expansion of frontiers, not only in terms geographical frontiers, but also physiological, intellectual, and scientific frontiers. From these desires for change and expansion, world-systems emerged through "the international division of labor, created by European imperialism and derived from the exploitation of a vast global periphery by the expansionary core states" (Crowell 1997: 5). WST is based off an unequal two-part trade system that consists of economically stronger core polities and peripheral groups that supply products to the core (Wallerstein 2004).

Since the initial definition of WST, other researchers have amended the two part system by rethinking the nature of interactions between the core and periphery (Ekholm and Friedman 1985; Hall and Chase 1993; Kohl 1987; Kristiansen 1987; Peregrine 1996; Upham 1992). Ekholm and Friedman (1985) started by suggesting a new 'global system', which includes all types of societies, capitalist or non-capitalist. For this, Ekholm and Freidman added two additional structures to the two-part system: dependent structures and independent structures. Dependent structures are defined as societies that depend on their interactions within the global system for reproduction but are neither a core nor a periphery. Independent structures are societies that do not depend on the global system for reproduction, but their reproduction can affect or be affected by the larger system. Next Kristiansen (1987) suggested that some world-systems are comprised of a two-tiered hierarchy of core/periphery relations. The first tier, or higher level, is based "on organization at a regional scale, but lacking formal exploitative relationships," and the second tier or lower level is based on "organization between local centers and attached communities, with formal exploitive relationships" (Kristiansen 1987: 82). The second tier (or the independent structures) are themselves smaller world-systems that are exploiting local cores and can survive without connecting to the larger world-systems or first tier.

Nevertheless, "these independent world-systems also exist within a larger world-system based on the dependent, but not necessarily exploitive, trade of elite symbols between independent polities" so that the elites can socially reproduce (Peregrine 1996: 488). Kohl (1987) also expanded on the independent structures concept by arguing that in some world-systems, the peripheries are independent structures and are not dependent on the core. As part of his research on Bronze Age societies in the Near Eastern regions, Kohl (1987: 20) notes that "the peripheries

situated between cores were far from helpless in dictating the terms of exchange". Instead, Kohl suggests that ancient core/periphery relations could not be classified as a strong core and weak peripheries since the peripheries themselves could change or end any relationship as they deemed necessary. Upham (1992) introduced a concept very similar to the previously described independent structures but called it 'empty spaces' within the world-systems. He defines this new term as "areas between major population centers: areas without obtrusive or distinctive evidence of people" (Upham 1992: 141), areas that cause obstacles for travel, trade, and communication. Upham goes further and explains that these empty spaces are not devoid of people, but are home to communities that rely on different social, political, and economic organizations than other places in the system. Maintaining relations with 'empty spaces' requires the core and periphery to create "mechanisms for interrelating with these peoples, mechanisms that are often maintained with difficulty" (Peregrine 1996: 487).

The model of WST that will be used in this thesis was created by archaeologists in order to understand the position of Canadian Arctic hunter-gatherers within the world-systems during the historic period. In 2013, Friesen outlined the five-step progression from no contact to a high degree of interaction. A majority of the hunter-gatherer communities start existing in the external zone, which is before Euroamercan contact when hunter-gatherers have no part in the world-systems. Communities can then transition into the autonomous zone (Friesen 2013), or what Ekholm and Friedman would have classified as independent structures (Ekholm and Friedman 1985). At this point, communities did not have direct contact with the world-systems but were indirectly being affected through trade with neighboring hunter-gatherer communities that had already progressed in the system (Friesen 2013). Archaeologically, this zone is evident by similar artifact types for neighboring groups, a minimal amount of trade goods, and a maintained subsistence-settlement system. With increased contact with the world economy, either directly or through more frequent indirect exchange, hunter gatherers then move into the contact periphery zone. At this point, the hunter-gatherers belong to what Kristiansen called a second tier of the world-system (Kristiansen 1987). They interact with neighboring groups and have their own independent traditional world-system, but are linked with the first tier, or world-economy, as a way to gain prestige (Friesen 2013; Kristiansen 1987). This can be identified archeologically by an increased number of trade goods and aggregation sites where regional groups meet to trade. Trade goods begin to replace previous artifact categories. There is higher separation of core and

periphery groups through the presence of prestige items, and greater effort made to acquire materials for exportation. Increased sedentism is also predicted at this stage (Friesen 2013). Once they are in regular and direct contact with the world-economy groups can move into the marginal periphery zone. Archaeologically, trade items originate from a greater number of regions, aggregation sites suggest denser occupations, and trade goods are abundant with an increased proportion of bulk goods to preciosities. The subsistence-settlement system changes in order to better fit with the world-economy, more effort is made to obtain goods for export, and a further divide develops between core and peripheries in terms of wealth, sedentism, and social complexity (Friesen 2013). Once groups become fully integrated into the world-systems, they are part of what Friesen (2013) refers to as the dependent zone.

Table 3-1. Friesen's (2013) world-systems model with archaeological expectations for each zone.

Zone	Expectation
External Zone	No contact with world-systems
Autonomous Zone	Indirect contact Similar artifact types as neighbor groups Minimal amount of trade goods Maintained subsistence-settlement system
Contact Periphery Zone	Increased number of trade goods Formation of aggregation sites Replacement of artifact categories with trade goods Presence of prestige items separating core and periphery Greater effort to acquire materials for exportation Increased sedentism
Marginal Periphery Zone	Further increased number of trade goods Aggregation sites supporting denser occupations Trade goods are abundant with an increased proportion of bulk to preciosities Further changes in subsistence-settlement system (i.e., sedentism, social complexity, and wealth) More effort to obtain goods for export
Dependent Zone	Fully integrated into the world-systems

In respect to Healy Lake Village site, the ethnographic record suggests that the community would have been in the autonomous zone at the beginning of occupation (A.D. 1880), with only indirect contact through the aid of intermediaries and a heavy reliance on the subsistence-settlement system (McKennan 1959; Shinkwin et al. 1980). By the end of occupation (A.D. 1946) the village appears to have transitioned into the marginal periphery zone, or even fully into the dependent periphery zone (McKennan 1959; Shinkwin et al. 1980). Is there evidence of these transitions in the zooarchaeologically record? This could be evident by an

increase in trade goods especially items of prestige, an increase in sedentism, and a concentration on hunting fur-bearers indicating more of an effort to obtain goods for export.

3.2 Ethnographic Records as Analogies

Debates regarding the use of the ethnographic record as a means of interpreting the archaeological record have been ongoing since the 1960s (Binford 1967; Wobst 1978). An analogy is defined as "a relation of likeness, between two things or of one thing or with another, consisting in the resemblance not of the things themselves, but two or more attributes, circumstances or effects" (Binford 1967: 1). In this section, a summary of this debate will be provided, beginning with a discussion of the benefits of using the ethnographic record, and then moving to a consideration of its limitations. It is necessary to demonstrate both the advantages and limitations of using ethnographic records when interpreting the archaeological material from Healy Lake Village site.

By the end of the 19th century, ethnographers were studying cultural groups that were being quickly decimated by famine, disease and acculturation; the goal of much of this work was to document their cultural practices, beliefs, and all around daily routines before they or their practices went extinct (Orme 1974; Wobst 1978). From there, anthropologists began to recognize the utility of these ethnographic records as a way to better understand the archaeological materials that were being uncovered (Binford 1967; Gould and Watson 1982; Orme 1974). In 1898, ethnographer Harlan Smith stated that "archaeology is a method of reconstructing, from scant remains, the ethnology of a people now gone, and of whom we can learn only from such of their remains as have endured the test of time" (Orme 1974: 199). Thirty-three years later, archaeologist Randall-MacIver claimed that "without anthropology [ethnography]… archaeology was 'blind with one eye and short-sighted with the other" (Orme 1974: 200). Over time, two forms of analogy became prevalent: the direct historical approach and the general comparative approach. The first method, the direct historical approach, is believed to be more reliable since it relies on ethnographies from societies with a common subsistence strategy and from similar ecological region (Gould and Watson 1982; Orme 1974). The latter method, the general comparative approach, is favorable when there is not ethnographic data for a group with a similar subsistence strategy in a defined area. Both approaches aid in the identification and interpretation of unknown archaeological tools, features, and ways of life.

Over time, archaeologists shifted away from using the ethnographic record as a means of obtaining direct interpretations and moved towards using them to create testable hypotheses for addressing the archaeological material (Binford 1967). This appears to be where the majority of discussions and debates arose, i.e., how to properly apply these analogies. The first downside to using the ethnographic record to interpret the archaeological record is that the groups being observed already had contact with the world market and other more complex societies, and were transitioning away from traditional lifestyles (Wobst 1978). Ethnographers had to rely on informants to reconstruct already diminished cultures, and in some instances, the informants themselves were referencing hearsay since that part of traditional way of life had already been replaced or lost (Wobst 1978).

A second flaw that must be addressed refers to the temporal application of the ethnographic records (Orme 1974). The further back in the past the archaeological assemblage dates to, the less applicable the modern ethnographic record should be treated. There are many areas where analogies can be accurately applied; however, "there have existed behaviour patterns that are not represented in the modern ethnographic record, and therefore to interpret the past in terms of the present can be very misleading, indeed dangerous" (Orme 1974: 204-205).

The final flaw is that most ethnographies are recorded in "quick time" (Binford 1981b; Wobst 1978). Since the ethnographers have a limited about of time and space to acquire as much cultural knowledge as they can, they often receive a 'worm-eye view of reality' (Wobst 1978). What this means is that the less time spent observing the communities, there is less of a chance to see the driving factors behinds decisions, such as seasonal changes, religious ceremonies, and technological change, as well as instances where they are actively avoiding stresses, hazards, and catastrophes (Wobst 1978).

Even with these critical limiting factors, creating and using analogies from the ethnographic record as an analytical tool to interpret the archeological record continues to be a common practice. Ethnographic analogies are being used to formulate testable hypotheses and are not being used as a direct source, as they are not sufficient as explanation, but more so as illustration (Orme 1974). Researchers are now using other methodologies, such as experimental work, in conjunction with ethnographic analogies to obtain a more comprehensive interpretation of the archaeological record (Gould and Watson 1982).

In Chapter 2, I presented information from ethnographies that were recorded in the Upper Tanana Athabascan territory contemporaneous to the historic component at Healy Lake Village site. In using this record, I attempt to reduce the biases that can be caused from using ethnographic analogies. In addition, it potentially can highlight if and how Healy Lake varies from other groups in the region by revealing differences between what the ethnographic record states happened and what is present in the zooarchaeological record.

3.3 Project Expectations

Project expectations were created using ethnographic records and guided by the two theoretical frameworks previously discussed (HBE and WST).

3.3.1 Seasonality

The old Athabascan village of Healy Lake is located on the shore of a mid-sized lake and is near the confluence of the Tanana and Healy Rivers, which made it the ideal location for a fish camp that consisted of "a single cabin and a number of tents" (Cook 1989: 115). For the first 30 years of historic period occupation (A.D. 1880-1910), the village represented a summer fishing camp, where the inhabitants primarily exploited fish, migratory and non-migratory birds, and moose (Cook 1989; Haynes and Simeone 2007; McKennan 1959). For the rest of the year, the residents would migrate between their spring caribou hunting camps, fall communal caribou fences, and winter semi-permanent camps in order to exploit the range of seasonally available resources (Haynes and Simeone 2007; McKennan 1959). After A.D. 1910, the village was occupied year-round due to the establishment of a nearby trading post (Cook 1989; Haynes and Simeone 2007). After this shift, the faunal assemblage should reflect hunting events from all four seasons. If these two occupation periods are distinct from one another, I would expect the pre-1910 remains to reflect the summer fishing camp and the post-1910 remains to reflect year round hunting. However, I predict the assemblage is going to represent a palimpsest, or mixing, of the two occupation periods and that all seasons will be represented.

Specific seasons of occupation can be identified based on which species were being exploited. Ethnographically, caribou, muskrat, and ptarmigan were hunted in the spring; moose, ground squirrel, birds and fish in the summer; moose, caribou, sheep, fish, and ptarmigan in the fall; and moose and ptarmigan were sought after during the winter months (Table 3-1; Haynes and Simeone 2007; McKennan 1959; Vitt 1971). Since there is overlap in species and seasons,

age profiles of caribou remains will be used to help parse apart seasons of occupation. Remains identified to 0-2 months of age would represent summer kills whereas remains identified to 4-10 months could represent fall and winter hunting trips.

Table 3-2. Seasonal species exploitation list created from McKennan's (1959) ethnographic description for the Tanana.

Spring *(Caribou Hunting Camps)*	**Summer** *(Fishing Camps)*	**Fall** *(Communal Caribou Fences)*	**Winter** *(Semi-Permanent Camps)*
Caribou Muskrat Ptarmigan	Moose Ground Squirrel Ptarmigan Duck Geese Swan Fish	Moose Caribou Sheep Ptarmigan Fish	Moose Ptarmigan

3.3.2 Faunal Procurement and Processing

As previously stated, HBE will be used to assess animal procurement strategies through the use of prey-choice and patch-choice models. Based on the ethnographic records, caribou, moose and fish were the most important food sources for Upper Tanana Athabascans (McKennan 1959; Vitt 1971). If these species are abundant on the landscape, then they should dominate the faunal assemblage; however, if these species were not abundant in the area, then the residents should incorporate more species, such as smaller game and birds. Furthermore, if the residents were not purely hunting for subsistence purposes, a different pattern should emerge, with a higher reliance on fur-bearing animals demonstrating a stronger dependency on fur trading and the cash economy.

In terms of settlement patterns, Shinkwin et al. (1980) proposed that the locations for villages and other semi-permanent settlement types was strongly influenced by the proximity of the five central subsistence resources: caribou, moose, sheep, fish and fowl. If Healy Lake Village site is consistent with this model, then at least three of these resources should be present within a 10 mile radius of the village, and all five should be available within a 40 mile radius. However, the construction of a trading post at the mouth of the Healy River, approximately 5 miles away from the site, might skew decision making about settlement location due to the availability of an assortment of western goods.

Food processing practices can be identified based on Binford's (1981) descriptions of four types of cut marks that are caused by different processing behaviors: 1) skinning, 2) dismemberment, 3) filleting, and 4) marrow consumption (Table 3-2; Binford 1981a). While skinning a carcass, cut marks can occur on the lower leg bones (lower tibia, shaft of metatarsals, and phalanges), front leg bones (shaft of the radius-ulna), and the head. For the limb bones, skinning marks will be present on the proximal and distal sections but not on the articular sections. Dismemberment cut marks are associated with articulation surfaces and can be identified on almost all elements. Filleting marks are also found on almost all elements, but typically are focused on or around the fusion scars. The only elements that would not have cut marks caused by filleting would be the skull, mandible, cervical vertebrae, and carpals. Finally, Binford states that cut marks from marrow consumption are identified as "longitudinal scratches and striations along the shafts of long bones" (Binford 1981a: 134). Since the inhabitants of Healy Lake Village site had access to different modes of transportation (i.e., human pulled sleds and potentially dog pulled sleds), I predict that all forms of processing should be evident in the assemblage, since sleds could facilitate entire carcasses being brought back intact for processing at the village versus at the kill site.

Table 3-3. Cut marks on skeletal element by processing behavior. Modified from Binford (1981a: 136-142; Table 4.04).

Skeletal Part	Action Producing Mark
Skull	Dismembering, Food Preparation, Skinning, Consumption, and Killing
Mandible	Dismembering and Skinning
Cervical Vertebrae	Dismembering
Thoracic Vertebrae	Dismembering and Filleting
Ribs and Sternum	Dismembering and Filleting
Pelvis and Sacrum	Secondary Butchering, Dismembering and Filleting
Femur	Dismembering and Filleting
Tibia	Dismembering, Filleting, and Marrow Consumption
Tarsals	Dismembering and Filleting
Metatarsals	Dismembering, Filleting, Skinning, and Marrow Consumption
Humerus	Dismembering and Filleting
Scapula	Dismembering and Filleting
Radius-Ulna	Dismembering, Filleting, and Marrow Consumption
Carpals	Dismembering
Metacarpals	Dismembering, Filleting, Skinning, and Marrow Consumption

Both archaeologically and ethnographically, utility indices have been created to rank skeletal parts in terms of their food value, such as meat and grease (Binford 1978; Lyman

1994a). By statistically comparing element survivorship with a variety of utility indices, I can also address food processing behavior at archaeological sites (Binford 1978). Positive correlations to five utility indices, meat (uncorrected and corrected), bone grease, marrow, and meat drying, could indicate selection of elements for meat drying, marrow extraction, and grease rendering. A negative correlation to any of the indices does not necessarily mean the action was not being conducted, but it could mean that sections of the animal were removed from the location for a variety of reasons, such as food during hunting trips, or trade for other commodities (Binford 1978).

3.3.3 Spatial Distribution

Because the faunal material removed from the Upper Cultural layers is provenienced to 5 ft. by 5 ft. blocks and ranges from the ground surface to 10 in. below the surface, spatial analysis will be limited to a broad assessment of activity areas at the site. Processing areas at Healy Lake Village site could potentially be segregated by species type, skeletal elements, or cooking activities (i.e., marrow extraction, grease rendering, or meat drying). Activity areas that are separated by species type or element could be identified by the presence of clusters of a particular species or element in distinct areas of the site. For example, if species were processed in different areas, then caribou remains may be clustered together in one location of the site, with separate concentrations of moose, birds, and smaller mammal remains. This would be similar for element processing areas; clusters of long bone shaft fragments representing marrow processing could be distinct from clusters of long bone ends and axial elements signifying grease rendering. The site will be divided into two excavation areas (northern and southern area) and remains from each will be statistically compared to the utility indices. The presence of separate meat drying, marrow extraction, or grease rendering areas could be revealed through a positive correlation between a single index and one of the two excavation areas. If there are no distinct activity areas present in the sample, it is predicted that there will be no correlation between the various utility indices and excavation area, or all of the indices will show the same correlation in both areas.

3.3.4 Euroamerican Interaction

Based on the presence of guns, beads, and other non-Native items, the inhabitants of Healy Lake had trade relations with the Euroamerican settlers (Appendix A; also see Cook 1989). If the residents of Healy Lake were active participants in the fur trade, then there should

be an abundance of fur bearing animals, represented by high Minimum Number of Individuals (MNI) counts for those species. If they were trading only the fur to the settlers, the metapodials, phalanges, carpals and tarsals may be absent since these often remain with the fur after processing (Reitz and Wing 2008). If meat was purchased at Euroamerican trading posts, there should be remains from non-Native species such as pigs, cows, and chickens, present at the site. However, non-local meat products might have been purchased off the bone and or in cans, leaving no zooarchaeological evidence. If the inhabitants were trading locally hunted meat to the Euroamericans miners, the expectations include a negative correlation between element frequency and the meat index, since the Healy Lake residents could have traded or sold high utility portions to the miners, keeping the lower utility sections for their own consumption (Crabtree 1990; deFrance 2009).

Chapter 4 Materials and Methods

4.1 Faunal Material

4.1.1 Excavation Methods

The faunal material used for this project was recovered from the Upper Cultural level at the Healy Lake Village site. Drs. John Cook, Robert McKennan and an archaeological team excavated the site from 1968-1972 (Cook 1969, 1989). Cook excavated 169 5 x 5 foot (ft.; 1.5 x 1.5 meter [m]) units in 2 inch (in.; 5.08 centimeters [cm]) arbitrary levels on the small peninsula that projects into Healy Lake along the northeast shoreline (Figure 4-1; Cook 1989; Younie 2015). The excavated area covers approximately 20% of the total site, with the historic component being contained within the first 10 in. (25.4 cm) of the excavation, which is stratigraphically associated with the root mat and sod (Cook 1989). Stratigraphically, the site is divided into three layers from top to bottom: "1) A humus and sod layer that contained historic period artifacts, 2) A relatively thick layer of loess (60-120 cm) that included excavation layers 1-10, and 3) A thick layer of coarser sandy silt (also wind-blown) overlying … the degraded Birch Creek Schist bedrock" (Figure 4-2) (Cook 1996: 323). The loess layer is further divided into four subdivisions: A2, B2, A2b, and B2b. The dirt removed during excavation was not screened since "screening would, perhaps, have saved some of the larger flakes that might have been lost but not enough to have justified the time spent screening" (Cook 1969: 70).

During the 1967 excavation, Cook identified five cultural levels but later revised his interpretations into four levels (Cook 1996). The revised cultural sequence will be used for interpretive purposes in this thesis. Cook started the stratigraphic profile with the ground surface and sod layer by calling it the Upper Cultural zone which is also assigned to Level 0 or the historic component at the village. Next is the Athapaskan (Athabascan) stage which incorporates Levels 1-3, followed by the Transitional stage (Levels 4-5), and ending with the Chindadn stage (Level 6-10) (Table 4-1; Cook 1996). A network of red colored horizontal bands of clay were identified in the upper B horizon and are characteristic of paleosols, or buried soil horizons.

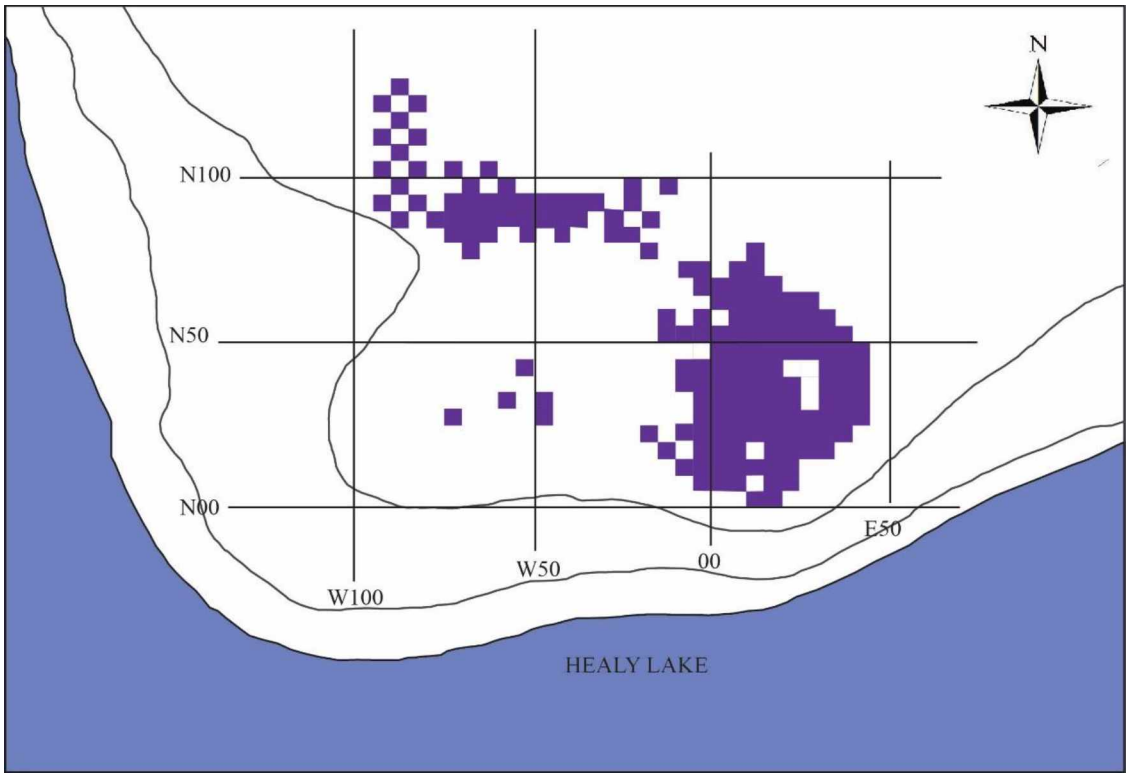

Figure 4-1. Healy Lake Village site complete excavation area; modified from Cook (1989).

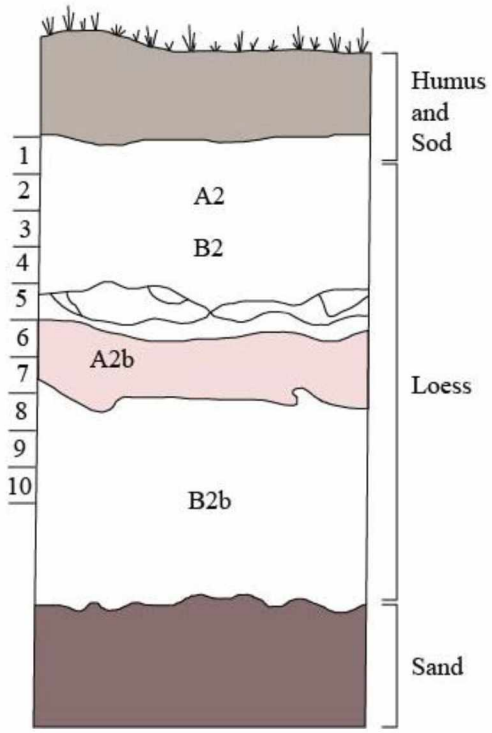

Figure 4-2. Stratigraphic profile at Healy Lake Village site. Re-digitized from Cook (1996).

Table 4-1. Revised cultural chronology. Information originated from Cook (1996) and adapted from Younie (2015).

Cultural Stage	Level	Soil Association	Artifacts
Upper Cultural	0	Humus and Sod Layer	Bones, beads, cartridge casings, iron arrowheads, china, glass, harmonicas, thimbles, nails, wire, buttons, and a wide variety of metal products.
Athapaskan	1-3	Loess (Subdivisions A2 and B2)	Microblades, campus cores, notched and lanceolate points, burin spalls
Transitional	4-5	Loess (Subdivision B2)	Few; Representative of an in-situ transition to Athabascan Cultural systems
Chindadn	6-10	Loess (Subdivisions A2b and B2b)	Thin triangular- and teardrop-shaped points, lanceolate bipoints, blade and microblade technology, hearths, bones

A majority of the previous analyses at Healy Lake focused on the lithic material removed from the subsurface levels (Cook 1969; Younie 2015). In 2013, Carol Gelvin-Reymiller and Holly McKinney began initial identification of the faunal collection, but no formal analysis was conducted. Reports note that more than a fifth of the total archaeological material excavated from the site is associated with the historic period (Cook 1989). In the Upper Cultural layer alone, more than 5,000 bones, antler, and teeth were collected. Other items that were collected include glass beads, buttons, can lids, nails, bottle caps, and tobacco cans (Appendix A; Cook 1989).

4.1.2 Project Limitations

It is necessary to outline a number of limitations that impact analysis of the faunal remains from Healy Lake Village site. First and foremost, during the excavation, the archaeological team did not screen the sediment from the Upper Cultural level. By not screening, the faunal assemblage will be biased towards larger elements as well as larger species such as moose, caribou, and sheep (Pokines 2000; Thomas 1969). Therefore, there could be an inaccurate and artificially deflated representation of fish, birds and small mammals, as well as smaller elements such as carpals and tarsals (Pokines 2000; Thomas 1969). Migratory birds, fish, and small mammals are key indicators of seasonality. Similarly, the inclusion of small game and processing of smaller elements can provides evidence of a wider diet breadth. Due to potential bias in the representation of small animal and small bones, I will not be able to fully evaluate seasonality of the occupation or diet breadth.

The second way the collection is potentially biased relates to the fact that the site and excavation area were initially interpreted as a dog yard for contemporary Healy Lake occupants (Cook 1989); the modern village is approximately a mile southeast of the old village (Younie 2015). The presence of dogs at the site could affect the faunal assemblage in a variety of ways. The first are gnawing, deletion of certain skeletal elements, and destruction of epiphyses (Binford 1981a; Blumenschine 1988; Bunn 1986; Bunn and Kroll 1986; Marean and Spencer 1991; Marean et al. 1992; Waguespack 2002). Dog gnawing can be very destructive, but it can also merely result in surface damage that would not affect the identification and analysis of the specimens. The other two possibilities, element deletion and epiphyseal destruction, are more severe. Element deletion could result in the further underrepresentation of the smaller bones, such as carpals and tarsals, as well as small species, such as fish, birds, and hares (Binford 1981a). As for epiphyseal destruction, carnivores are highly attracted by greasy cancellous bones, which unfortunately are also "the bone portions that are most identifiable" (Marean and Spencer 1991: 646). In addition to physically altering the bones, dogs tend to compromise the stratigraphy of a site by moving bones vertically through the act of digging, which could bring prehistoric material to the surface or bury the historic material in the lower levels. Dogs, like other carnivores, also move bones over horizontal space as a way to keep other dogs from stealing and eating their bones (Marean and Bertino 1994; Marean and Spencer 1991; Marean et al. 1992). Finally, researchers have noted that dogs were typically fed from the same food sources as the human occupying a site (Binford 1978; Ingstad 1954; Waguespack 2002). Dogs could have been fed any portion of the animal carcass, but as Waguespack (2002) notes, innominates and scapulae were a common food source. If the occupants from the modern Healy Lake village were indeed feeding their dogs with scraps and bones from their hunts, certain elements may appear to be more abundant in the Upper Cultural faunal assemblage but were in fact a later inclusion. Unfortunately, any more recent bones could not be separated from the Upper Cultural material, which means that, if present, they are included in this analysis.

The final limitation relates to the lack of field notes discussing the Upper Cultural layer. The site had only been abandoned for approximately 28 years at the time of excavation, and the excavation team was interested in exploring and researching the prehistoric components. As such, they did not focus their time on the historic (or Upper Cultural) material. That being said, of the 169 blocks excavated, seven hearth features were identified in the notes based on the

presence of charcoal concentrations, fire-cracked rocks, and burned bones. The field notes for 64 blocks merely provide artifact lists with no detailed description of disturbances, features, post holes, etc. Another 56 blocks had no notes for the Upper Cultural layer, and field notes could not be located at all for the final 18 blocks. Since the field notes for the Upper Cultural layer are incomplete and limited, spatial analyses are required to gain a better understanding of the distribution of faunal remains.

4.1.3 Faunal Material

The faunal material utilized in this analysis originated from collections stored at the University of Alaska Museum of the North (UAMN) in Fairbanks, and through a loan to Cook from the Canadian Museum of History (CMH) in Ottawa. For the first two years of analysis, all bones, teeth, and antler were included (both unidentifiable and identifiable), but due to time constraints, after the second year, only identifiable bones were fully analyzed. Note that I still processed all of the Upper Cultural material during that final year of study; identifiable remains were pulled and analyzed separately.

Of the 169 blocks excavated, 121 blocks yielded faunal material (71.6% of the excavation), while 48 (28.4%) had no faunal remains (Figure 4-3). Of the 121 blocks with fauna, the full sample was analyzed from 49 blocks, whereas analysis was limited to identifiable materials for the remaining 72 blocks (Figure 4-4). Since the entire assemblage of non-identifiable remains was not included in the analysis, the results are a representation of taphonomic factors (burning, weathering, root etching, etc.) that affected the site. In total, 4087 bone, tooth, and antler fragments were included in this analysis.

4.2 Zooarchaeological Data Collection Methods

Data collection was conducted in the University of Alaska Fairbanks Anthropology Department's Zooarchaeological laboratory and the Archaeology Department laboratory at the UAMN.

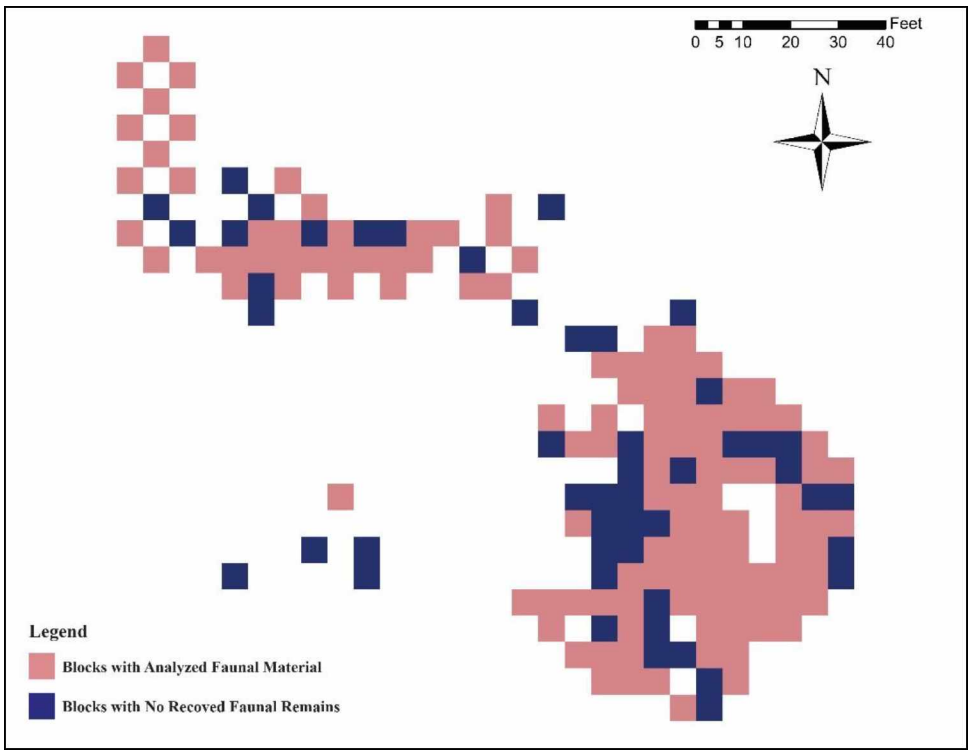

Figure 4-3. Blocks with analyzed faunal material at Healy Lake Village site.

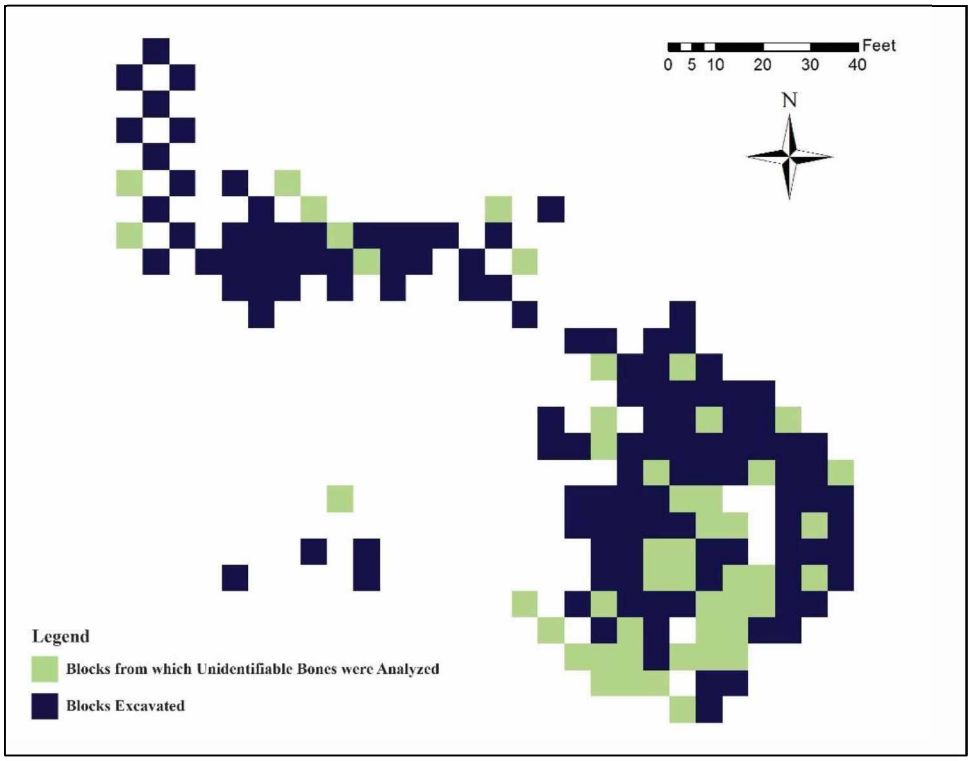

Figure 4-4. Blocks from which unidentifiable bones were fully analyzed.

4.2.1 Coding System

Data entered into Microsoft Excel included the UAMN or CMH catalog number, my assigned specimen number, provenience information, excavator's name, and raw count of pieces of bone, teeth, and antler present. Since they collected materials in bulk, most of the museum catalog numbers represent multiple bones. I assigned each identifiable bone a new specimen number and bagged them separately so that I could locate the specimens more easily. Indeterminate long bone shaft fragments that were analyzed were also assigned individual specimen numbers. I assigned bags with multiple unidentifiable bone fragments, multiple tooth fragments from same species, or multiple cranial fragments from same size class and burn code a single specimen number. My specimen numbers were arbitrarily assigned starting with number '1' representing the first identifiable specimen, indeterminate long bone shaft fragment, or bag of unidentifiable bone fragments.

Provenience information consists of the block, quadrant, level, and depth designations. Cook named the blocks by the southwest corner placement on the excavation grid system. For example, block N65E10 is located 65 ft. North of the N0 line, which is the southern-most extent of the excavated area at the site, directly north of the lake shoreline, and 10 ft. West of the W/E0 line. For the Upper Cultural level, most of the blocks were excavated by the entire 5 ft. x 5 ft (1.5 x 1.5 m), block, but a small handful of blocks were further divided into quadrants and named by their location in the block, i.e., northwest quadrant, northeast quadrant, southeast quadrant, and southwest quadrant. Levels were arbitrarily assigned and the Upper Cultural material is limited to Level 0. Individual artifact depths were not recorded for this level, and all specimens were given the distinction of 0 in. below surface; however, depths range from ground surface to 10 in. below surface.

Next, each specimen was assigned to a size class, a taxon, skeletal element, portion of the element, percentage of the potion, side, and proximal and distal fusion status. The size class categories follow a modified version of Thomas' (1969) classification system (Table 4-2). In 1969, Thomas outlined five animal size classes defined by weight ranges: class I (<100 g), class II (100 g-700 g), class III (700 g-5 kg), class IV (5 kg-25 kg), and class V (>25 kg). Since Thomas created the size class system for a region that is dominated by smaller animals, I had to modify it to help differentiate between larger species. The size class categories used for this project consist of: a very small class (<100 g), small class (100 g-700 g), medium class (700 g-25

kg), large class (25 kg-180 kg), and a very large class (>180 kg). The taxon, skeletal element, and side were determined with the aid of three separate comparative collections: University of Alaska Fairbanks Department of Anthropology Zooarchaeological comparative collection, UAMN Mammalogy and Ornithology comparative collections, and the Idaho Virtual Museum (https://virtual.imnh.iri.isu.edu/). Percentage and portion of elements were assigned following Stiner's (2004) coding system (See Appendix B). Each bone was also assigned an epiphyseal fusion status for both the proximal and distal ends of the bones, if applicable. Bones were assigned a value from 0-3 depending on fusion status: 0 meaning unfused, 1 partially fused, 2 completely fused, and 3 not applicable due to the absence of epiphyseal end. I used Takken Beijersbergen and Hufthammer's (2012) caribou fusion ages to determine the age at death for caribou remains (Table 4-3). Currently, there is no modern comparative data for determining the age at death for moose based on epiphyseal fusion, so moose age profiles at Healy Lake Village site will not be addressed.

Table 4-2. Animal size class classification (modified from Thomas 1969).

Thomas 1969 Size Classes			**Modified Size Classes**		
Class	Weight	Examples	Class	Weight	Examples
Class I	<100g	Meadow Mouse, Pocket Gopher	Very Small	<100g	Lemming, Shrew, Vole
Class II	100g – 700g	Squirrel, Chipmunk	Small	100g – 700g	American Red Squirrel, Pika
Class III	700g – 5kg	Cottontail Rabbit, Marmot	Medium	700g – 25kg	Arctic Ground Squirrel, Hare, Fox, Porcupine
Class IV	5kg – 25kg	Coyote, Bobcat	Large	25kg – 180kg	Caribou, Dall's Sheep
Class V	>25kg	Deer, Mountain Sheep	Very Large	>180kg	Moose, Bison, Bear, Horse

In addition to species and element identification, a variety of taphonomic variables were recorded for each bone or bulk bag of bones in this analysis: burning, weathering, root etching, cut marks, percussion marks, carnivore damage, rodent damage, and the presence of other taphonomic alterations on the specimens. The degree of burning was visually assigned using Stiner et al.'s (1995) burn code system (Table 4-4). Weathering was identified following

Behrensmeyer's (1978) surface and subsurface classification system, which outlines seven stages of weathering (Table 4-5). I followed Todd's (1993) system for root etching, where 00 stands for 0% of the bone surface showing root etching, 05 represents 5% root etching, 10 for 10%, 20 for 20%, 30 for 30%, 40 for 40%, 50 for 50%, 66 for 60-100% of the surface showing root etching, and 77 for not applicable. As for the other taphonomic variables (cut marks, percussion marks, carnivore damage, rodent damage, and other taphonomic alterations), I identified their presence using a microscope at 4x magnification following the criteria of Fernández-Jalvo and Andrews (2016).

Table 4-3. Age of fusion for post-cranial bone for Rangifer tarandus (caribou) from Takken Beijersbergen and Hufthammer (2012).

Element	Age
Atlas (individual segments)	0-2 mo
Vertebral Segments	0-2 mo
Scapula (Tuber)	2-6 mo
Pelvis (Os Pubis & Os Ischium Fusing, followed by the Illium)	2-15 mo
Atlas (Dorsal Suture Line)	2-15 mo
Radius (Proximal)	4-10 mo
Vertebrae (Sacrales 2-4)	4-15 mo
Humerus (Distal)	6-15 mo
Phalanges I & II	6-18 mo
Vertebrae (Sacrales 1 & 5)	15-35 mo
Radius & Ulna (Diaphyses)	18-30 mo
Tibia (Distal)	18-30 mo
Metacarpal (Distal)	18-30 mo
Metatarsal (Distal)	18-30 mo
Calcaneus	18-42 mo
Sacrum (Epiphyses)	35-42 mo
Costae	35-45 mo
Radius (Distal)	36-48 mo
Femur (Proximal)	36-48 mo
Femur (Distal)	36-48 mo
Tibia (Proximal)	36-48 mo
Ulna (Proximal)	42-48 mo

Element	Age
Humerus (Proximal)	42-54 mo
Vertebrae (Cervical 2-5)	45-? mo
Vertebrae (Lumbar)	45-? mo
Vertebrae (Thoracic)	45-? mo
Pelvic Halves	45-? mo

Table 4-4. Burned bone coding system (Stiner et al. 1995)

Burned Bone Code
0 (Not Burned; Cream/Tan Color)
1 (Slightly Burned; Localized and <50% Carbonized)
2 (Lightly Burned; >50% Carbonized)
3 (Completely Black; 100% Carbonized)
4 (More Black than White; Localized and <50% Calcined)
5 (More White than Black; >50% Calcined)
6 (Completely White; 100% Calcined)

Table 4-5. Weathering code classification (Behrensmeyer 1978).

Weathering Code
0 (Unweathered)
1 (Cracking, Normally Parallel to Fiber Structure)
2 (Outermost Thin Layers Flaking)
3 (All External Concentrically Layered Bone has been Removed)
4 (Bone Surface May be Loose Enough to Fall Away and Weathering Penetrates into Inner Cavities)
5 (Bone Falling Apart in Situ)
9 (Not Applicable)

Finally, each specimen was weighed on a digital scale to the nearest tenth of a gram and the maximum length was measured using calipers to the nearest tenth of a millimeter. I weighed bags containing multiple unidentifiable bone fragments, tooth fragments, or cranial fragments as bulk samples and did not measure the length of each of those fragments.

4.3 Quantitative and Analytical Procedures

4.3.1 NISP, Normalized NISP, %Normalized NISP

The number of identified specimens (NISP) is defined as "the number of skeletal elements (bones and teeth) and fragments thereof – all specimens- identified" to the taxon (Lyman 2008: 27). For my analysis, NISP refers to any fragment that can be identified to size

class (i.e., small, medium, small/medium, large), animal type (i.e., rodent, ungulate, Anadinae), taxon and element. I calculated NISP values by adding the number of bone, tooth and antler fragments by species, animal type, or by size class.

After the NISP was totaled, I calculated normalized NISP (nNISP) values and percentage of normalized NISP values (%nNISP) for each species. nNISP values are calculated by dividing the NISP value for a given element by the number of times that element occurs in a skeleton, and is generally used for measuring abundance (Grayson and Frey 2004; Morin and Ready 2013). As outlined by Morin and Ready (2013), it is important to note that cranial values were divided by two in order to prevent inflation of head counts compared to limb bones; this makes sense because cranial parts generally come in pairs. %nNISP values were calculated by setting the highest nNISP value to 100% and scaling the rest of the values within the same species accordingly (Grayson and Frey 2004). NISP and NISP derived values are preferable for specific analyses since other quantitative values (Minimum Number of Elements [MNE] and MNI, described below) tend to "inflate the representation of rare elements," and because thase values are not additive (Morin and Ready 2013: 237).

4.3.2 MNE

The minimum number of elements (MNE) is defined as the minimum number of skeletal portions necessary to account for the specimens representing that portion (Lyman 1994a; Lyman 2008). The MNE values are calculated by "determining how many elements are represented by the fragmentary remains, based on the presence of overlapping landmark features, and hence not the same as NISP" (Reitz and Wing 2008: 226). There are multiple methods for calculating MNE, such as including shaft fragment by estimating the percentage of the circumference, excluding shaft fragments, and by reconstructing whole elements (Bunn 1986; Klein and Cruz-Uribe 1984; Lyman 1994b; Marean and Spencer 1991; Morlan 1994; Reitz and Wing 2008; Stiner 1994). For my analysis, MNE was determined based on overlapping landmark features as well as age. I also took shaft fragments into account, but only if there were landmarks, such as ligament scars, foramina, or other distinctive features present on the specimen. MNE values can be used for assessing the degree fragmentation in an assemblage by looking at NISP: MNE ratios. (Lyman 1994a).

4.3.3 MNI

The minimum number of individuals (MNI) "traditionally means the minimum number of individual animals necessary to account for all of the kinds of skeletal elements found in the skeleton of a taxon" (Lyman 2004: 100). In order to derive this value, one can take side, sex, age, and archaeological context into account (Lyman 1994a; Reitz and Wing 2008). For this analysis, side and age of the specimens were considered but did I not code or identify sex; therefore it was not a factor in determining the MNI value for each species. I took overlapping features into account while calculating MNI. Since there can only be one right proximal femur present in an animal's body, if I identified three right proximal femora from a caribou, there would have to be at least three individuals present. Age is another necessary factor when deriving MNI values. For example, if there are three right proximal caribou femora from adults and two left proximal caribou femora (one adult and one juvenile) in an assemblage, and age was not taken as a factor, one could say there were only three individuals. However, with age involved, one could more accurately assess that there are a minimum of four individuals, three adults from the right femurs, and one juvenile from the left femur. MNI values provide a prediction for how many individuals were transported to the site (Reitz and Wing 2008).

4.3.4 MAU, %MAU

The minimum animal unit (MAU) is a quantitative unit defined by Binford in 1984. Once the MNE value is calculated, that number is divided by the number of those elements which are present in a skeleton for that particular species (Lyman 1994a; Reitz and Wing 2008). Percent minimum animal units (%MAU) is derived in a similar way to %nNISP, by assigning the highest MAU value to 100% and scaling the rest of the values within the same species accordingly (Binford 1978; Reitz and Wing 2008). Binford created MAU and %MAU as a way to assess skeletal element frequencies in an assemblage. These values can be plotted against utility indices in order to better understand economic strategies (Lyman 1994a; Reitz and Wing 2008).

4.3.5 Density Values

I conducted two separate analyses for density mediated attrition. One treated the entire site as a single sample, while the other divided the excavation into north and south areas in order to better understand site formation and post-depositional processes. Bone density values were assigned based on Lam et al.'s (1999) computed tomography (CT) scan sites. Lam et al. used

these to calculate BMD_1 and BMD_2 values, the latter of which takes into account internal cavities (Lam et al. 1999). I calculated density mediated attrition for moose and caribou bones. Unfortunately, there are no density values currently available for moose; however, I utilized caribou values as a proxy given that moose and caribou are both cervids. Density mediated attrition was not explored for other species because the NISP counts were limited and because I lacked density values for those species. Each identifiable fragment was assigned density values based on the scan sites present on the specimen. As such, some bones are represented by one value whereas others could have multiple values if more than one scan site is present. Lam et al. (1999) do not provide density values for all bones (i.e., distal and proximal sesamoids, dew claws, maxilla, upper orbit, lateral malleolus). Consequently, those bones are not included in the analysis. I then compared the nNISP of each scan site against the values for bone density using Spearman's Ranked Correlation Coefficient and Kendall's tau-b, non-parametric tests, to determine if there is a correlation between survivorship and density (Clark 2017).

4.3.6 Fragmentation

The degree of fragmentation for the assemblage will be assessed using three different analytical methods. NISP: MNI ratios will be used to address how fragmented the remains are the collection. With greater fragmentation, NISP values will increase, but the MNI values should not change; however, this can be subjected to transportation biases (Marshall and Pilgram 1993; Todd and Rapson 1988). The NISP: MNE ratios will also be used in order to assess the intensity of fragmentation, with more fragmentation indicated by higher NISP: MNE ratios (Lyman 2008; Todd and Rapson 1988). The last analysis that will be used is the completeness index for carpals and tarsals, which assesses the degree of post-depositional destruction of a collection (Marean 1991). Experimental studies have demonstrated that the carpals and tarsals are less likely to be subjected to fragmentation from human or carnivore actions, so if these are fragmented, it indicates that the assemblage is altered by post-depositional factors (Clark 2017). Only moose and caribou remains will be used to assess fragmentation due to possible biases in the representation of other species due to lack of screening.

4.3.7 Statistical Procedures

I used three non-parametric statistical procedures to test associations between variables: Kendall's tau-b, Spearman's Ranked Correlation Coefficient, and two-way Chi-square (Madrigal

1998). Spearman's Ranked Correlation Coefficient "can be used when the data [has] violated parametric assumptions such as non-normally distributed data" (Field 2009:179). It also requires that the relationship between variables is linear (Madrigal 1998). Conversely, Kendall's tau-b "should be used rather than Spearman's coefficient when you have a small data set with a large number of tied ranks" (Field 2009: 181). Two-way chi-Square, or goodness of fit, is used to assess if the "sample data are likely to represent the distribution of frequencies in the population" (Heiman 2000: 414). All statistical tests used p=0.05 as the significance threshold. Kendall's tau-b and Spearman's Ranked Correlation Coefficient were conducted using JMP Pro 13, whereas chi-square was calculated using Preacher's (2001) computer software.

4.3.8 Utility Indices

I compared nNISP values for caribou and moose remains against five different utility indices for the entire site and then by north and south excavation areas. This analysis follows the methodology of Morin and Ready (2013). All indices used in this analysis were calculated for caribou and will be applied to both caribou and moose since there are no indices available for the latter species. The indices I used are Metcalfe and Jones' (1988) simplified meat utility index (MUI), Metcalfe and Jones' (1988) food utility index (FUI), Morin and Ready's (2013) corrected food utility index (CFUI), Binford's (1978) bone grease index (Grease) from the Nunamiut spring grease-rendering episode, Morin's (2007) unsaturated marrow index (UMI), and Friesen's (2001) meat drying index (MDI). I statistically tested for correlation between the nNISP values and the indices using Spearman's Ranked Correlation Coefficient with a significance value of p=0.05.

4.4 Fourier Transform Infrared Spectroscopy

4.4.1 Research History

By understanding the temperature of the heat source and where burned specimens originated, researchers can piece together a comprehensive picture of food processing areas and discard practices (Berna 2017). Cooking food, such as roasting, boiling, grease rendering, and marrow extraction, all generally occur in the low temperature category (≤100°C); these bones would visually be classified as unburned (Wandsnider 1997). Fourier transform infrared spectroscopy (FTIR) is an analytical method that can confirm the visual classification of burning as well as the temperature of the heat source. Unfortunately, FTIR does not identify low enough

temperatures to identify cooking processes since 200°C is generally the lowest temperature that can be identified in the mid-infrared spectra (Thompson et al. 2009). After consumption, bones can be burned for many different reasons. They can serve as for a source of fuel, be discarded in fires to keep the site clean and as a means of reducing the presence of carnivores, or burned from unintentional exposure to overlying hearths (Clark and Ligouis 2010). By verifying visual identifications of bone burning based on color, FTIR can help identify hearth features, middens, or other combustion areas, and to indicate where food processing or bone discard occurred at a site.

FTIR is an analytical method that has been in use since the early 1980s (Berna 2017; Messerschmidt and Harthcock 1988). This technique is:

> Based on the vibrations of bonds within a molecule. An infrared spectrum is commonly obtained by passing infrared radiation through a sample and determining what fraction of the incident radiation is absorbed at a particular wavelength. The wavelength at which any peak in an absorption spectrum appears corresponds to the frequency of vibration of a specific part of a molecule. (Thompson et al. 2009: 911)

For this particular approach, the mid-infrared range (4000-400 cm^{-1}) of the electromagnetic spectrum is used to analyze practically "any sample in any state" of preservation or digenesis (Thompson et al. 2009: 911). There are two standard methods used for solid samples: potassium bromide pellets (KBr) and attenuated total reflection (ATR). The other methods available are more commonly used for liquid and gas samples (Smith 2011). As many researchers have documented, both of the methods used for solids (KBr and ATR) have their advantages and disadvantages. ATR is the recommended and preferred method for burned bone analysis, primarily because it is fast and easy (Berna 2017; Squires et al. 2011; Thompson et al. 2009; Thompson et al. 2013).

In the presence of heat, bones undergo many different stages of physical and chemical changes (Berna 2017; Subias 2002; Thompson 2004, 2013). Thompson (2013: 416) characterizes these as: "dehydration (loss of water between 100° and 600°C), decomposition (loss of the organic component 300° - 800° C), inversion (alteration of the inorganic phase 500° - 1100°C), and fusion (coalescence of the crystal structure 700°C +)". From these four distinctions, Thompson (2013) defined three distinct temperature groups that can be identified in the mid-

infrared spectra range: low temperature burning (<400°C), mid temperature burning (400-700°C), and high temperature burning (>700°C). Using FTIR, the distinct peaks that are produced can identify source temperature to the nearest hundred degrees from (Thompson et al. 2009).

4.4.2 Method

For the FTIR analysis, the bones were initially grouped into four broader categories: black, grey, white, and weathered. I further divided the black bones into three subcategories: black from carbonization, black from element staining, and black for unknown reasons. I added the element staining category since bones can appear black for a variety of different reasons besides burning, such as manganese staining. Element staining was visually identified following protocols defined by other researchers under the supervision of one of my advisors, Dr. Jamie Clark. For bones that were entirely black in color, stained bones were identified by the glossy shine on the exterior surfaces, whereas burned bones are matte black. For the bones that were not entirely black, staining was identified by the presence of black spots and black discoloration on the exterior surfaces.

A sample of 34 bones was analyzed using FTIR to confirm visual identifications of burning and the temperature of the heat source. The sample consisted of six bones that were black either by staining or burning, three bones identified as black due to carbonization and not stained, five black due to possible staining and not burned, seven grey bones that could possibly be calcined, seven white bones that were classified as calcined, one white bone that was identified as weathered and sun-bleached, and five bone that are unburned but weathered with some staining present.

The analysis took place at the University of Tübingen in Germany under Dr. Susan Mentzer's supervision in May 2017. The FTIR analysis was conducted on a Carry 660 Bench with a diamond crystal Pike Gladi-ATR Vision attachment by the accumulation of 36 scans with a resolution of 4 reciprocal wavelengths. A standard preparation protocol was used in this analysis, which includes grinding a small amount of the sample with a mortar and pestle and placing the ground sample directly on the diamond crystal (Smith 2011). Each sample was analyzed in three separate areas on the bone. The areas were chosen by color, texture, and/or shine (matte or glossy) of the bone surface. For example, on the weathered bones: sample one would be taken from the unburned or beige section of the bone, one would be taken from a black

spot on the bone, and a third sample would be taken from a shiny spot on the bone. This was done in order to account for intra-bone variation. The resulting spectra were compared using Essential FTIR and a comparative collection of spectra compiled by Dr. Mentzer at the Institution of Archaeological Science, Eberhard Karls Universität Tübingen.

4.5 Spatial Analysis

Spatial analysis was conducted to explore possible distribution patterns present at the site. For this, I converted the block coordinates as defined by Cook into data that was compatible with the attribute table in GIS ArcMap 10.2. Then I assigned the x-coordinate to be the easting values for the grid system, and the y-coordinates to be the northing values. The point grid system was converted into a raster file using the point to raster conversion tool, and symbology for the maps was set as stretched. This analysis was performed to explore the general distribution of all bones, bones by burn code, bones by size class, long bone fragments versus long bone ends, and for bones identified as moose, caribou, and bird remains. The distribution maps were created using NISP values except for the burn code maps, which used frequency data.

Chapter 5 Results

5.1 Spatial Distribution

The general spatial distribution map of the Upper Cultural layer at Healy Lake Village site documents an uneven distribution of faunal specimens between the north and south excavation areas. There is a high concentration of bones in the southeast corner of the site as signified by the dark squares in Figure 5-1, which is comprised of blocks N20E15, N20E20, and N25E20. Other blocks across the site show higher concentrations of faunal material including blocks N05W00 and N35E20 in the south excavation area, and blocks N85W45 and N100W90 in the northern area, though these are not as dense. Differences in the faunal assemblage from the two excavation areas will be explored throughout this chapter and discussed in more detail in Chapter 6.

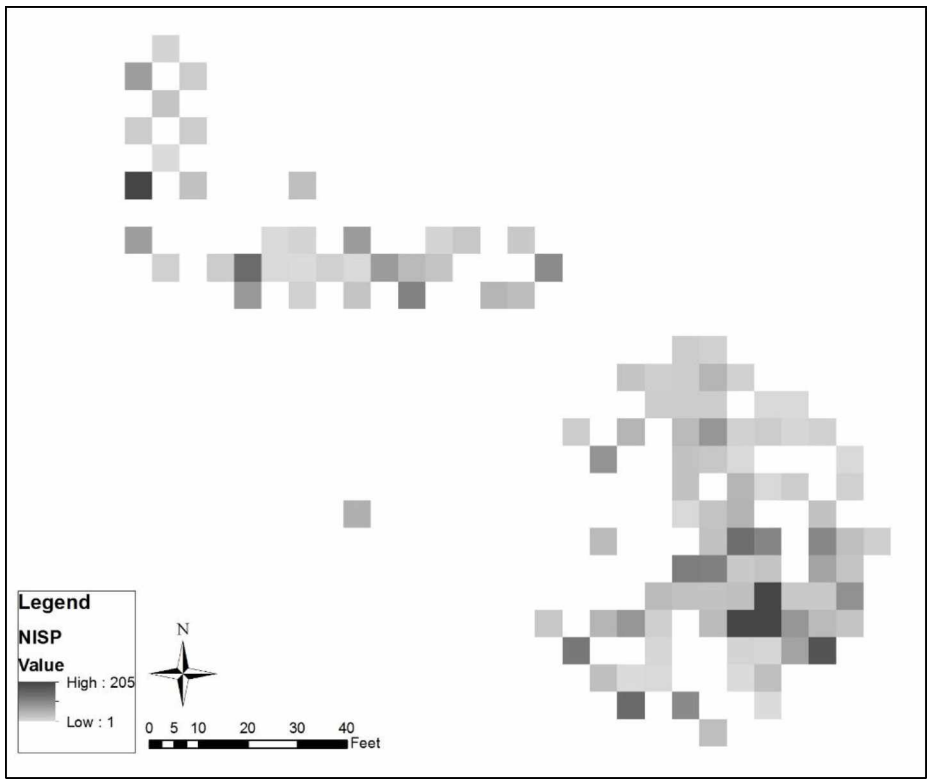

Figure 5-1. Distribution map of identified specimens in the Upper Cultural layer. Values are depicted as a number of identified specimens located in a single block. Unidentified fragments are not depicted on this map.

5.2 Size Class

Faunal analyses of the historic component at the Healy Lake Village site revealed a broad spectrum of taxa, ranging from very large mammals to birds and fish (Table 5-1). A majority of the identified specimens fell into the large mammal category (NISP = 1401), followed by very large mammals with an NISP of 778, medium size mammals with NISP of 207; only 21 specimens were identified to the small mammal category. Birds and fish made up a small portion of the assemblage with NISPs of 62 and 95 respectively; thus is not unexpected in a collection that was not screened. As mentioned in Chapter 4, a lack of screening during excavation biases the assemblage towards larger mammals and bones, and away from small species such as birds, fish, and small mammals. The remaining specimens were too fragmentary to assign to one size class or the other and were placed in categories that bridge two classes (i.e., small/medium and large/very large). A large portion of the assemblage fell into the unidentifiable category, totaling 1399 specimens.

Table 5-1. Size class distribution for the identifiable faunal material (as a count and as a percentage) for the site and for the two excavation areas separately.

Size Class	Total NISP	Percentage	North	Percentage	South	Percentage
Fish	62	2.3%	—	—	62	3.1%
Bird	95	3.5%	47	6.6%	48	2.4%
Very Small Mammal	1	0.0%	—	—	1	0.1%
Small Mammal	20	0.7%	5	0.7%	15	0.8%
Small/Medium Mammal	36	1.3%	5	0.7%	31	1.6%
Medium Mammal	207	7.7%	40	5.6%	167	8.5%
Medium/Large Mammal	35	1.3%	2	0.3%	33	1.7%
Large Mammal	1401	52.1%	492	68.9%	909	46.0%
Large/Very Large Mammal	53	2.0%	16	2.2%	37	1.9%
Very Large Mammal	778	28.9%	107	15.0%	671	34.0%
TOTAL	**2688**	**100.0%**	**714**	**100.0%**	**1974**	**100.0%**

5.2.1 Size Class Spatial Distribution

In looking at the distribution of faunal remains by size class, I combined the small and medium size classes together in order to have a larger sample size for better comparison to the large and very large mammals (the medium/large size class was included in the large counts and the large/very large NISP number was included in the very large count). As demonstrated in Figure 5-2, small/medium remains are more abundant in the southern excavation area (NISP = 214 or 11% of the total NISP in the south) with very few specimens in the northern area (NISP = 50 or 7% of the total NISP in the north). Within the southern area of the site, there are three

blocks with higher concentrations of the smaller mammal remains. This contrasts with the distribution of large mammals (Figure 5-3), which are abundant in the south excavation area as well as the northern area. There are dense clusters of large mammals in both areas, but in general, the remains are abundant across the entire site (south NISP = 909 [46.0% of the total NISP in the south] and north NISP = 492 [68.9% of the total NISP in the north]). As for very large mammals, the remains are present in both north (NISP = 107 [15.0% of NISP in the north]) and south excavation areas (NISP = 671 [34.0% of NISP in the south]), but there are denser groupings of remains in the center of the southern area (Figure 5-4). These different distribution patterns could reflect separate processing and/or discard areas for different species, or they could reflect post-depositional movements from dogs, humans or natural forces that sorted the bones depending on size class. I will return to these issues later in the chapter.

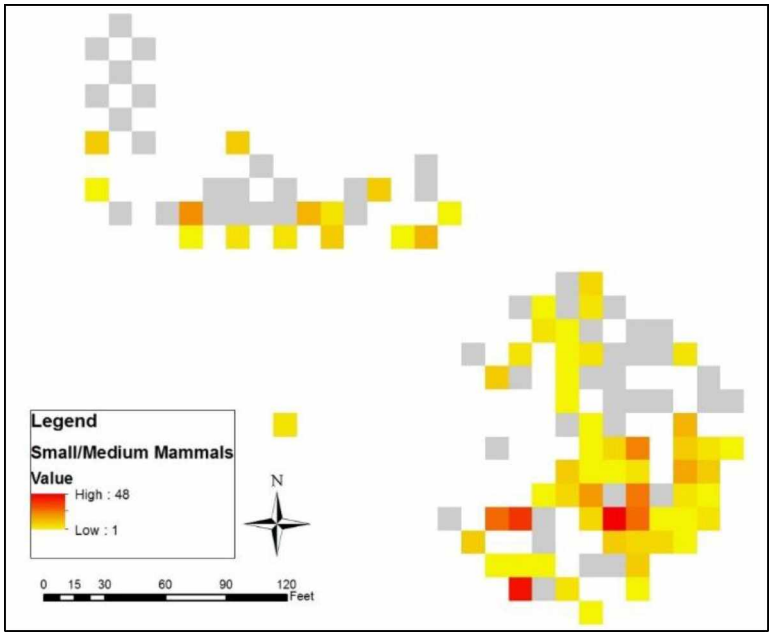

Figure 5-2. Distribution map of very small/small/medium mammal remains. Values are depicted as number of identified specimens for each size class category located in a single block.

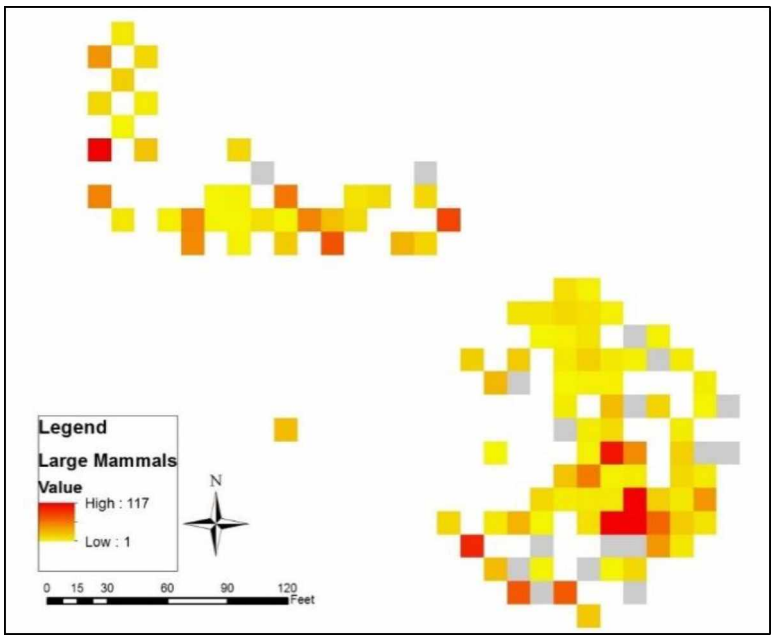

Figure 5-3. Distribution map of large mammal remains. Values are depicted as number of identified specimens for each size class category located in a single block.

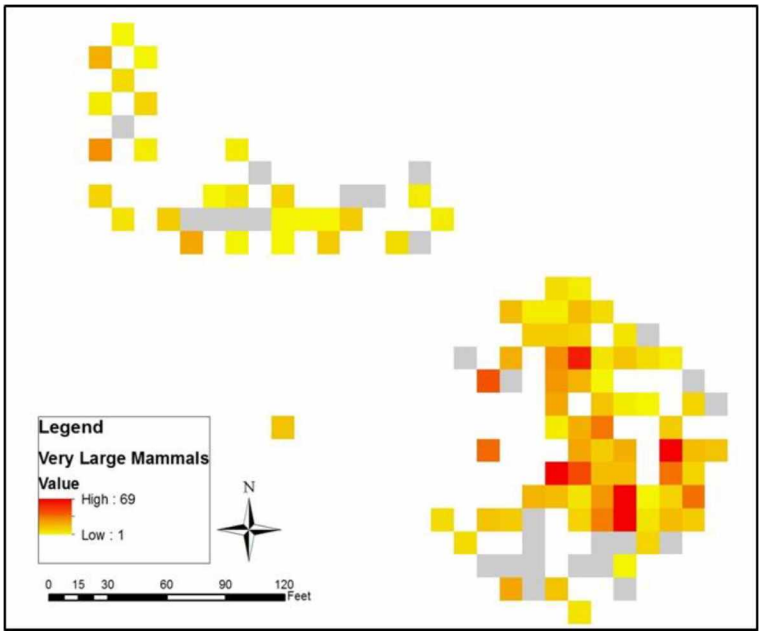

Figure 5-4. Distribution map of very large remains. Values are depicted as number of identified specimens for each size class category located in a single block.

5.3 Species and NISP Values

Of the specimens identified to taxon, I identified 18 mammal species, nine bird species, subfamilies, or families, and one fish species (Table5-2). The majority of the assemblage was identified as caribou (*Rangifer tarandus*) and moose (*Alces alces*), with NISPs of 759 and 626, respectively. Of the other mammal species identified, there are eight fur-bearing species present in the assemblage, which include fox (NISP of 5), lynx (22), marten (1), mink (3), wolf (2), hare (14), squirrel (1), and beaver (57). I classified 46 bones to the Anadinae family and five bones to the Tetraoninae subfamily. Nineteen bones were identified as bird but could not be identified further. Northern pike (*Esox lucius*) (1) was the only fish species identified in the Upper Cultural assemblage. In addition to confirmed identifications, a portion of the collection could only be identified to the closest species (signified by "cf." in front of the scientific name in Table 5-2). Since these bones could only be identified to the closest species, they will not be included the analyses of density mediated attrition, elemental frequency, and utility indices. Finally, five specimens were identified as rodent and an additional 46 bones as ungulate. They could not be identified further and the majority of the specimens consisted of tooth fragments.

Table 5-2. Species table with NISP, %NISP, MNI, and %MNI values.

TAXON	COMMON NAME	NISP	%NISP	MNI	%MNI
MAMMALS					
Lepus americanus	Snowshoe Hare	14	0.34%	4	5.80%
Erethizon dorsatum	North American Porcupine	3	0.07%	1	1.45%
cf. *Erethizon dorsatum*	North American Porcupine	1	0.02%	1	1.45%
Castor canadensis	Beaver	57	1.39%	7	10.14%
cf. *Castor canadensis*	Beaver	1	0.02%	1	1.45%
Ondatra zibethicus	Muskrat	9	0.22%	4	5.80%
cf. *Spermophilus parryii*	Arctic Ground Squirrel	6	0.15%	1	1.45%
Synaptomys borealis	Northern Bog Lemming	1	0.02%	1	1.45%
Rodent	Rodent	5	0.12%	—	—
Lynx canadensis	Lynx	22	0.54%	2	2.90%
cf. *Lynx canadensis*	Lynx	1	0.02%	1	1.45%
Canis Lupis	Dog	1	0.02%	1	1.45%
cf. *Canis Lupus*	Dog	2	0.05%	2	2.90%
Canis	Dog/Wolf/Coyote	2	0.05%	—	—
cf. *Canis*	Dog/Wolf/Coyote	7	0.17%	—	—
Vulpes vulpes	Red Fox	5	0.12%	1	1.45%
cf. *Vulpes vulpes*	Red Fox	1	0.02%	1	1.45%
Ursus americanus	Black Bear	1	0.02%	1	1.45%
cf. *Ursus artos*	Brown Bear	1	0.02%	1	1.45%
Martes americana	American Marten	1	0.02%	1	1.45%
Neovison vison	American Mink	3	0.07%	2	2.90%

TAXON	COMMON NAME	NISP	%NISP	MNI	%MNI
MAMMALS					
cf. *Neovison vision*	American Mink	1	0.02%	1	1.45%
Equus caballus	Horse	1	0.02%	1	1.45%
Alces alces	Moose	626	15.32%	7	10.14%
cf. *Alces alces*	Moose	23	0.56%	1	1.45%
Rangifer tarandus	Caribou	759	18.57%	13	18.84%
cf. *Rangifer tarandus*	Caribou	7	0.17%	2	2.90%
Ovis dalli	Dall's Sheep	2	0.05%	1	1.45%
cf. *Ovis dalli*	Dall's Sheep	1	0.02%	1	1.45%
Ungulate	Ungulate	46	1.13%	–	–
Small	Small	19	0.46%	–	–
Small/Medium	Small/Medium	23	0.56%	–	–
Medium	Medium	79	1.93%	–	–
Medium/Large	Medium/Large	35	0.86%	–	–
Large	Large	628	15.37%	–	–
Large/Very Large	Large/Very Large	17	0.42%	–	–
Very Large	Very Large	120	2.94%	–	–
	Total	2531			
BIRDS					
Bucephala clangula	Common Goldeneye	4	0.10%	2	2.90%
Histrionicus histrionicus	Harlequin Duck	1	0.02%	1	1.45%
Mergus merganser	Common Merganser	1	0.02%	1	1.45%
Anas platyrhynchos	Mallard	11	0.27%	1	1.45%
Aythya affinis	Lesser Scaup	1	0.02%	1	1.45%
Branta canadensis	Canada Goose	5	0.12%	1	1.45%
Cygnus	Swan	2	0.05%	1	1.45%
Anadinae	Geese, Swans, Ducks	46	1.13%	–	–
Tetraoninae	Capercallies, Grouse, Ptarmigans	5	0.12%	–	–
Aves	Bird	19	0.46%	–	–
	Total	95			
FISH					
Esox lucius	Nothern Pike	1	0.02%	1	1.45%
Fish	Fish	61	1.49%	–	–
	Total	62			
	TOTAL	**2688**	**100.00%**	**69**	**100.00%**

5.3.1 Species Distribution

Distribution maps were created for bird, caribou and moose remains in order to identify potential differences between the north and south excavation areas. Bird bones are identified in low quantities across the entire site; however, there are two blocks that contain higher concentrations of avian bones, one in the northern excavation area (N85W70 with NISP = 33, or 4.6% of the total NISP in the North) and one in the southern (N15E30 with NISP = 23, or 1.2%

of the total NISP in the south) (Figure 5-5). Given the smaller overall size of the sample from the northern excavation area, a chi-square test was conducted to explore whether the relative frequencies of birds (as compared to total NISP) was different in the two excavation areas. The test reveals that the different distribution of bird bones is significant (χ^2 = 26.501, p <0.0001). Taking this a step further, it can be noted that common goldeneye and harlequin duck remains only appear in the northern area, where as the common merganser and lesser scaup are only present in the southern area. Unfortunately, given that none of the sediment was screened, this pattern might not be an accurate representation. As a quick side note, fish bones are also only present in the southern excavation area, which is closer to the edge of the lake; however, the fish distribution could also be biased from the low sample size caused by the lack of screening.

Remains from both moose and caribou are present in almost every block that contained fauna, but caribou bones are significantly more common in the northern excavation area (χ^2 = 183.099, p <0.0001) (Feature 5-6). On the other hand, the distribution of moose remains show the opposite pattern. Moose bones are significantly more common in the southern excavation area (χ^2 = 37.341, p <0.0001) (Figure 5-7).

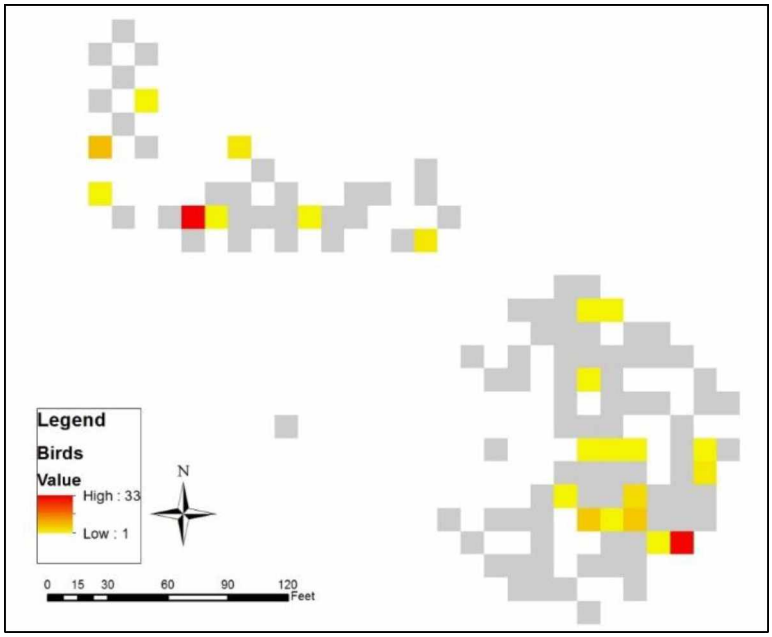

Figure 5-5. Distribution map of bird remains. Values are depicted as number of identified specimens located in a single block.

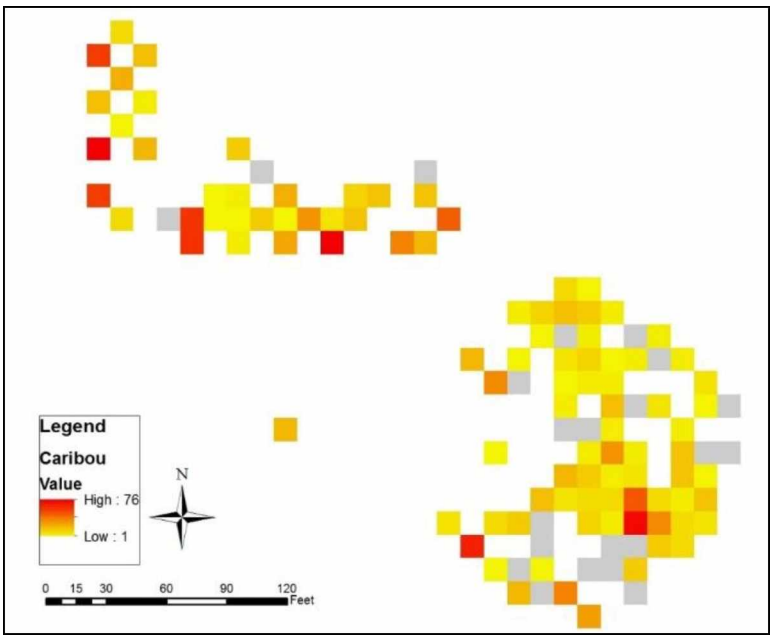

Figure 5-6. Distribution map of caribou remains. Values are depicted as number of identified specimens located in a single block.

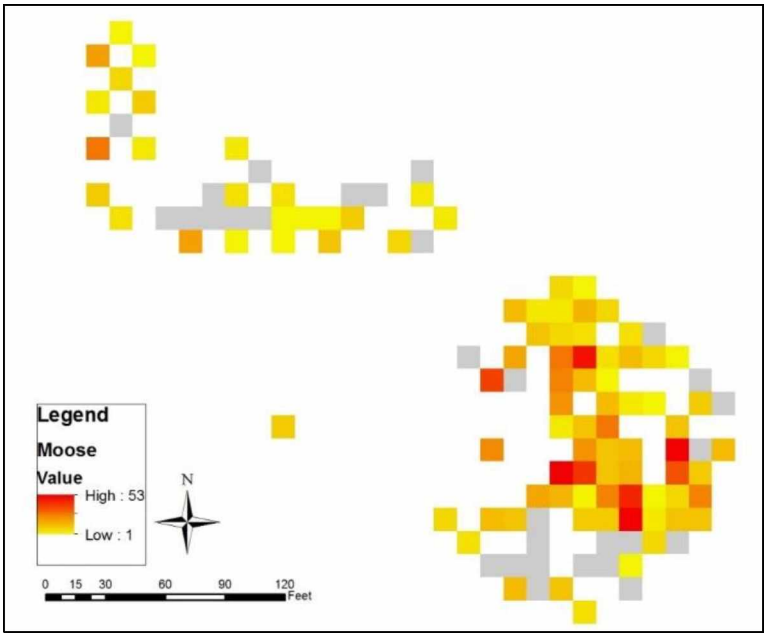

Figure 5-7. Distribution map of moose remains. Values are depicted as number of identified specimens located in a single block.

Table 5-3. Species table with NISP and percent of total in excavation area for the two excavation areas.

TAXON	COMMOM NAME	North Area		South Area	
		NISP	%	NISP	%
MAMMALS					
Lepus americanus	Snowshoe Hare	5	0.70%	9	0.46%
Erethizon dorsatum	North American Porcupine	1	0.14%	2	0.10%
cf. *Erethizon dorsatum*	North American Porcupine	1	0.14%	—	—
Castor canadensis	Beaver	10	1.40%	47	2.38%
cf. *Castor canadensis*	Beaver	—	—	1	0.05%
Ondatra zibethicus	Muskrat	2	0.28%	7	0.35%
cf. *Spermophilus parryii*	Arctic Ground Squirrel	1	0.14%	5	0.25%
Synaptomys borealis	Northern Bog Lemming	—	—	1	0.05%
Rodent	Rodent	—	—	5	0.25%
Lynx canadensis	Lynx	—	—	22	1.11%
cf. *Lynx canadensis*	Lynx	—	—	1	0.05%
Canis Lupis	Dog	—	—	1	0.05%
cf. *Canis Lupus*	Dog	2	0.28%	—	—
Canis	Dog/Wolf/Coyote	—	—	2	0.10%
cf. *Canis*	Dog/Wolf/Coyote	3	0.42%	4	0.20%
Vulpes vulpes	Red Fox	2	0.28%	3	0.15%
cf. *Vulpes vulpes*	Red Fox	—	—	1	0.05%
Ursus americanus	Black Bear	—	—	1	0.05%
cf. *Ursus artos*	Brown Bear	1	0.14%	—	—
Martes americana	American Marten	—	—	1	0.05%
Neovison vison	American Mink	—	—	3	0.15%
cf. *Neovison vision*	American Mink	—	—	1	0.05%
Equus caballus	Horse	1	0.14%	—	—
Alces alces	Moose	94	13.17%	535	27.10%
cf. *Alces alces*	Moose	—	—	23	1.17%
Rangifer tarandus	Caribou	399	55.88%	360	18.24%
cf. *Rangifer tarandus*	Caribou	—	—	7	0.35%
Ovis dalli	Dall's Sheep	1	0.14%	1	0.05%
cf. *Ovis dalli*	Dall's Sheep	—	—	1	0.05%
Ungulate	Ungulate	10	1.40%	36	1.82%
Small	Small	5	0.70%	14	0.71%
Small/Medium	Small/Medium	3	0.42%	20	1.01%
Medium	Medium	15	2.10%	64	3.24%
Medium/Large	Medium/Large	2	0.28%	33	1.67%
Large	Large	92	12.89%	536	27.15%
Large/Very Large	Large/Very Large	6	0.84%	11	0.56%
Very Large	Very Large	11	1.54%	109	5.52%
BIRDS					
Bucephala clangula	Common Goldeneye	4	0.56%	—	—
Histrionicus histrionicus	Harlequin Duck	1	0.14%	—	—
Mergus merganser	Common Merganser	—	—	1	0.05%
Anas platyrhynchos	Mallard	10	1.40%	1	0.05%
Aythya affinis	Lesser Scaup	—	—	1	0.05%
Branta canadensis	Canada Goose	4	0.56%	1	0.05%
Cygnus	Swan	1	0.14%	1	0.05%

TAXON	COMMOM NAME	North Area		South Area	
		NISP	%	NISP	%
Anatinae	Geese, Swans, Ducks	18	2.52%	28	1.42%
Tetraoninae	Capercallies, Grouse, Ptarmigan	1	0.14%	4	0.20%
Aves	Bird	8	1.12%	11	0.56%
FISH					
Esox lucius	Nothern Pike	—	—	1	0.05%
Fish	Fish	—	—	61	3.09%
	TOTAL	**714**	**100%**	**1974**	**100%**

5.4 MNI Values

The MNI values for all species showed similar patterns as the NISP values. Caribou (MNI of 13), moose (7), beaver (7), snowshoe hare (4), and muskrat (4) yielded the highest MNI values in the collection. Though beaver remains only represented 1.39% of the total NISP, they represent 10.14% of the total MNI values, which is equal to the moose even though moose that makes up 15.32% of the total NISP values. The remaining species all had MNI value of two (lynx, American marten, American mink, and common goldeneye) or one (all remaining mammals, bird and fish species) (Table 5-3). Between all of the species, a minimum of 69 different individuals is present in the Upper Cultural layer at the Healy Lake Village site.

5.5 Taphonomic Variables

A variety of taphonomic variables affected the Upper Cultural faunal assemblage from the Healy Lake Village site (Table 5-4). The most abundant are weathering (46.6% of the assemblage), burning (28.0%), root etching (12.9%), and cut marks (9.1%). Each variable will be discussed further in the following sections.

Table 5-4. Bone surface modification list with count and percentage, including identifiable and unidentifiable remains.

Bone Surface Modifications	Count Present	Percentage
Burning	1146	28.0%
Weathering	1904	46.6%
Root Etching	521	12.7%
Carnivore Damage	92	2.3%
Cut Marks	375	9.2%
Other	17	0.4%

5.5.1 Burning

As previously mentioned, burning was generally assessed through visual identification of bone surface color; to confirm my visual identifications, a subsample was tested using FTIR. The visual identifications of burning will be discussed first, followed by the FTIR results.

5.5.1.1 Visual Identification of Burning

Table 5-5. Burned bone code list (Stiner et al. 1995) with count and percentage for entire Upper Cultural assemblage.

Burned Bone Code	Count	Percentage
0 (Not Burned; Cream/Tan Color)	2941	72.0%
1 (Slightly Burned; Localized and <50% Carbonized)	113	2.8%
2 (Lightly Burned; >50% Carbonized)	147	3.6%
3 (Completely Black; 100% Carbonized)	147	3.6%
4 (More Black than White; Localized and <50% Calcined)	219	5.4%
5 (More White than Black; >50% Calcined)	143	3.5%
6 (Completely White; 100% Calcined)	377	9.2%
TOTAL	**4087**	**100.0%**

Looking at the total assemblage (including the unidentified specimens), the majority of the assemblage was visually identified as unburned, falling into the burn code 0 (2941 bones, 72% of the total). The remaining 28% of the faunal collection is distributed across all burning codes (Table 5-5). A few different patterns emerged when separating the identified bones and unidentified bones. For the unidentified bones, 35.2% are unburned, 23.7% of them are calcined, and the remaining 41.1% is spread throughout the remaining burn categories (Table 5-6). On the other hand, the majority of identified bones were coded as unburned (2295 of all mammal bones, 90.7%) (Table 5-7). Bird bones fell into only two categories, not burned (92 bones, 96.8% of bird bones) and calcined (3 bones, 3.2%) (Table 5-8).

Table 5-6. Burned bone code list (Stiner et al. 1995) with count and percentage for unidentified material in the Upper Cultural assemblage.

Unidentified Burned Bone Code	Count	Percentage
0 (Not Burned; Cream/Tan Color)	492	35.2%
1 (Slightly Burned; Localized and <50% Carbonized)	56	4.0%
2 (Lightly Burned; >50% Carbonized)	106	7.6%
3 (Completely Black; 100% Carbonized)	127	9.1%
4 (More Black than White; Localized and <50% Calcined)	167	11.9%
5 (More White than Black; >50% Calcined)	119	8.5%
6 (Completely White; 100% Calcined)	332	23.7%
TOTAL	**1399**	**100.0%**

Table 5-7. Burned bone code list (Stiner et al. 1995) with count and percentage for identified material in the Upper Cultural assemblage.

Identified Mammals Burned Bone Code	Count	Percentage
0 (Not Burned; Cream/Tan Color)	2295	90.7%
1 (Slightly Burned; Localized and <50% Carbonized)	57	2.3%
2 (Lightly Burned; >50% Carbonized)	41	1.6%
3 (Completely Black; 100% Carbonized)	20	0.8%
4 (More Black than White; Localized and <50% Calcined)	52	2.1%
5 (More White than Black; >50% Calcined)	24	0.9%
6 (Completely White; 100% Calcined)	42	1.7%
TOTAL	**2531**	**100.0%**

Table 5-8. Burned bone code list (Stiner et al. 1995) with count and percentage for bird remains identified in the Upper Cultural assemblage.

Bird Burned Bone Code	Count	Percentage
0 (Not Burned; Cream/Tan Color)	92	96.8%
6 (Completely White; 100% Calcined)	3	3.2%
TOTAL	**95**	**100.0%**

These patterns can be explained in a couple of different ways. First, the large sample of unidentifiable calcined bones is probably due to the fact that burned bones become brittle and prone to fragmentation, and are then unable to be identified to taxon and/or element (Stiner et al. 1995). This could also explain why 90.7% of the identifiable mammal bones were classified as unburned and very few were burned. As stated in Chapter 4, the epiphyseal ends are the most identifiable bone portions, but they are also attractive for human and carnivore destruction as well as being less dense and can fragment easily. So, the unidentifiable unburned bone could signal human grease processing, carnivore damage, or density mediated destruction and fragmentation.

5.5.1.2 FTIR Results

The results from the FTIR analysis indicate that visual identification of burning was accurate. All of the bones I identified as burned were confirmed to be burned. I was conservative in my identifications, which actually led to an underestimation of the frequency of burned material in the assemblage. Of the six samples that were visually identified as being black from either burning or staining, five were actually burned at a temperature of 500° C, and one sample was unburned but stained which explains the black color (UA69-049-01418). All three of the bones classified as being black due to carbonization were burned at 400 - 500° C. Only one of the five bones that were identified as black from elemental staining proved to be unburned

(UA69-049-01185). The remaining four samples were burned at 500° C. All seven samples that were visually classified as being grey calcined bones were burned at temperatures ranging from 500 - 700° C. The one bone that was identified as being white from weathering, particularly sun bleaching, was actually calcined at 1000° C. As for the other bones classified as being weathered but with slight staining, three were unburned or dried fresh and two were burned at 500 - 600° C. Finally, there were seven white bones identified as calcined, of those three were burned at 900-1000° C. The other four bones were burned but at slightly lower temperatures, 600 - 700° C. Since each sample was tested in three different areas, the results are an average of the three FTIR results; Table 5-9 displays the results by area for each sample.

Table 5-9. FTIR results for the 34 samples analyzed. Table includes UAMN catalogue number, my specimen number, visual identification, results for the three sampling areas, and interpretation of the results based on Thompson (2013).

UA Catalog#	HAH Catalog#	Visual Classification	FTIR Area 1 Temperature	FTIR Area 2 Temperature	FTIR Area 3 Temperature	FTIR Conclusions
69-49-01418	98	Black/Unknown	unburned	unburned	unburned	Stained
69-49-01804	214	Black/Unknown	500	400	500	Burned
69-49-05909	357	Black/Unknown	500	500	500	Burned
69-49-05909	358.2	Black/Unknown	500	500	500	Burned
69-49-05909	362	Black/Unknown	500	500	500	Burned
69-49-01891	413	Black/Unknown	500	600	500	Burned
69-49-05909	356	Black/Carbonized	500	500	400	Burned
69-49-05909	358.1	Black/Carbonized	400	400	400	Burned
69-49-01891	411	Black/Carbonized	500	500	400	Burned
69-49-01418	97	Black/Stained	500	500	500	Burned
69-49-01427	138	Black/Stained	500	500	500	Burned
69-49-01419	215	Black/Stained	500	500	500	Burned
69-49-01185	223	Black/Stained	unburned	unburned	unburned	Stained
69-49-05909	359	Black/Stained	500	500	500	Burned
69-49-01411	92	Grey/Calcined	700	600	600	Burned
69-49-01418	96.1	Grey/Calcined	700	600	600	Burned
69-49-01418	96.2	Grey/Calcined	600	500	500	Burned
69-49-01418	96.3	Grey/Calcined	600	600	600	Burned
69-49-01184	309	Grey/Calcined	600	600	500	Burned
69-49-05909	355	Grey/Calcined	700	700	600	Burned
69-49-01248	389	Grey/Calcined	500	500	500	Burned
69-49-05909	351	Weathered/White	1000	1000	1000	Calcined
69-49-01409	316	Weathered/Stained	unburned	unburned	unburned	Weathered
69-49-05909	363	Weathered/Stained	unburned	unburned	unburned	Weathered

UA Catalog#	HAH Catalog#	Visual Classification	FTIR Area 1 Temperature	FTIR Area 2 Temperature	FTIR Area 3 Temperature	FTIR Conclusions
69-49-05909	364	Weathered/Stained	fresh dry	fresh dry	unburned	Weathered
69-49-05909	365	Weathered/Stained	600	600	600	Burned
69-49-05909	366	Weathered/Stained	500	500	500	Burned
69-49-01411	93	White/Calcined	600	700	700	Calcined
69-49-01418	101	White/Calcined	700	700	700	Calcined
69-49-01399	290	White/Calcined	600	1000	900	Calcined
69-49-01399	293	White/Calcined	700	700	700	Calcined
69-49-01446	312	White/Calcined	1000	1000	1000	Calcined
69-49-01418	329.1	White/Calcined	900	1000	1000	Calcined
69-49-01418	329.2	White/Calcined	700	700	700	Calcined

5.5.1.3 Spatial Distribution of Burning

As previously mentioned, burned bones are abundant throughout the Upper Cultural faunal material. Unburned bone (Code 0) is present across the entire site, except for five blocks as demonstrated by the gray squares in Figure 5-8; however, those blocks do have burned material present. Once I removed burn code 0, or unburned material, and mapped the distribution of all other codes, a few hotspots with higher concentrations of burned material appeared (Figure 5-9). There is one main spot in the southwest corner of the southern excavation area, a second in the middle of the northern excavation area, and a few single blocks scattered across the site. When each burn code is mapped separately, other patterns emerge. Burn code 1, less than 50% carbonized, is denser at the top limits of the southern excavation area but is present throughout the entire site (Figure 5-10). Bones assigned to burn code 2 and 3, more than 50% carbonized and fully carbonized, respectively, appear to have a more even distribution across the site, except for one block in the middle of the northern area (Code 2) and one block at the southern limit of the southern block (Code 3) (Feature 5-11 and 5-12). Bones assigned to burn code 4, less than 50% calcined, are concentrated in the middle of the northern area and at the west and east limits of the southern excavation area (Feature 5-13). Bones classified as burn code 5, more than 50% calcined, are predominately located in the southern excavation with two hotspots at the southern limit and one at the eastern edge of the site (Feature 5-14). Finally, bones categorized to burn code 6, or fully calcined, are also located throughout the Upper Cultural level, but there are two denser concentrations: one in the northern excavation area and one in the southern as shown in Figure 5-15.

When comparing the spatial distribution of burning to where hearth features were identified during excavation (according to the field notes), six of the seven hearth features overlap with blocks with burned material present. Blocks N35E10, N80W40, and N120W90 contain both carbonized and calcined material, whereas block N55E15 only contains material that is less than 50% carbonized (code 1). Block N80W20 produced two burned bones out of 18 bones total, one classified as less than 50% calcined and the other is 100% calcined, and block N65E10 yielded bones identified as unburned and calcined but none of the intermediate burn codes. The seventh block that contained no burned bones, N20E10, was identified as a hearth feature based on a 1 ft (~30 cm) charcoal-rich circular area that was 1.5 in (3.81 cm) thick in the northwest corner. Bones were scattered throughout the level, but may not have been recovered in association with the hearth feature.

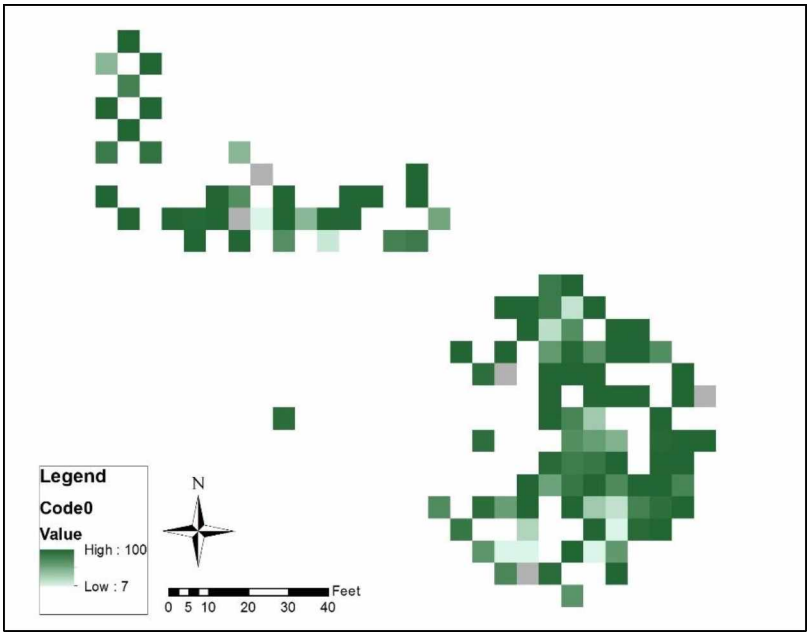

Figure 5-8. Distribution map of burn code 0. Values are depicted as percent of specimens (identifiable and unidentifiable) assigned to a burn code present in a single block. Values can range from 0% to 100% (or all specimens in the block).

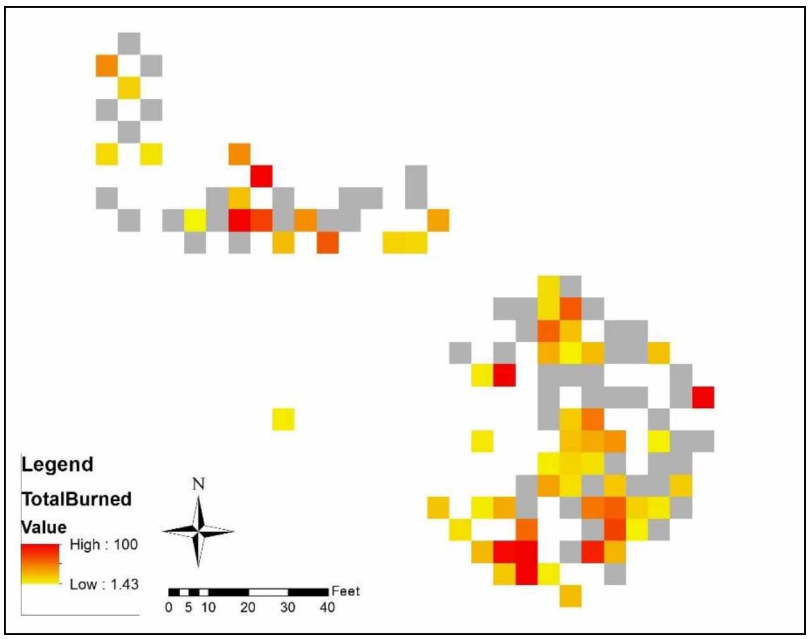

Figure 5-9. Distribution map of total burned material. Values are depicted as percent of specimens (identifiable and unidentifiable) classified to a burn code present in a single block. Value can range from 0% (or no specimens in the blocks, gray colored squares)

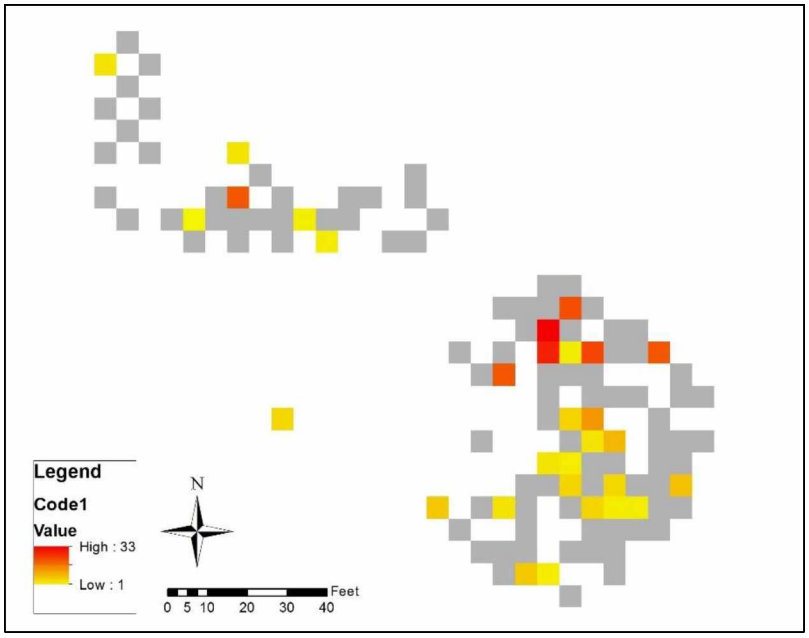

Figure 5-10. . Distribution map of burn code 1. Values are depicted as percent of specimens (identifiable and unidentifiable) classified to a burn code present in a single block. Value can range from 0% (or no specimens in the blocks, gray colored squares) to 100% (or all specimens in the block, red colored squares).

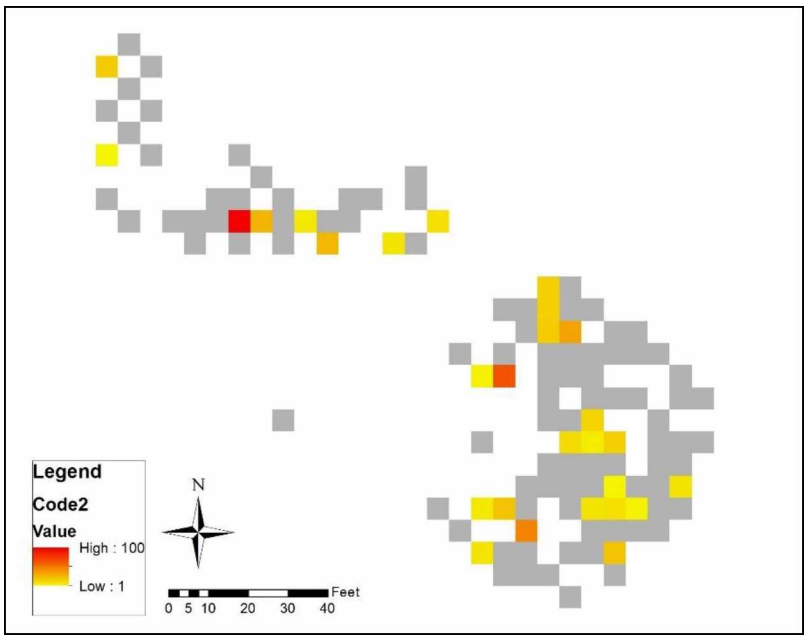

Figure 5-11. Distribution map of burn code 2. Values are depicted as percent of specimens (identifiable and unidentifiable) classified to a burn code present in a single block. Value can range from 0% (or no specimens in the blocks, gray colored squares) to 100% or all specimens in the block, red colored squares).

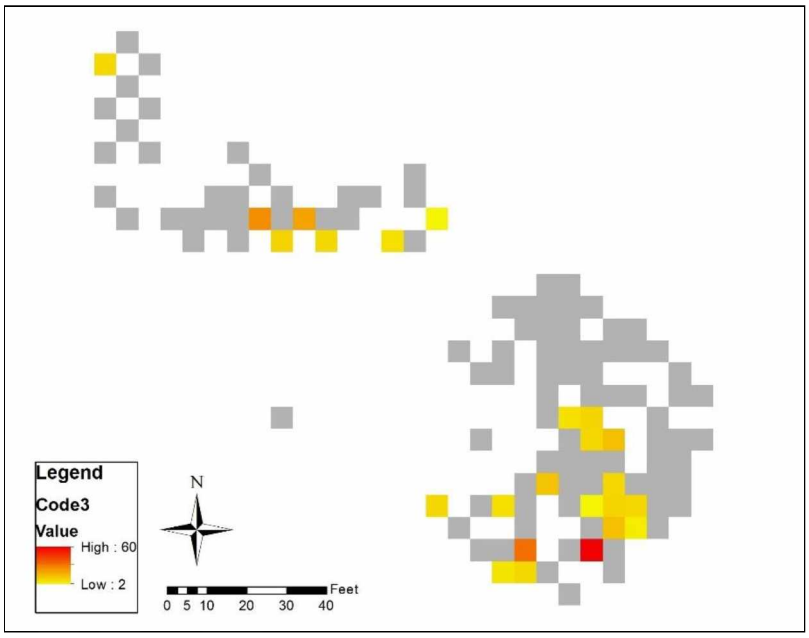

Figure 5-12. Distribution map of burn code 3. Values are depicted as percent of specimens (identifiable and unidentifiable) classified to a burn code present in a single block. Value can range from 0% (or no specimens in the blocks, gray colored squares) to 100% or all specimens in the block, red colored squares).

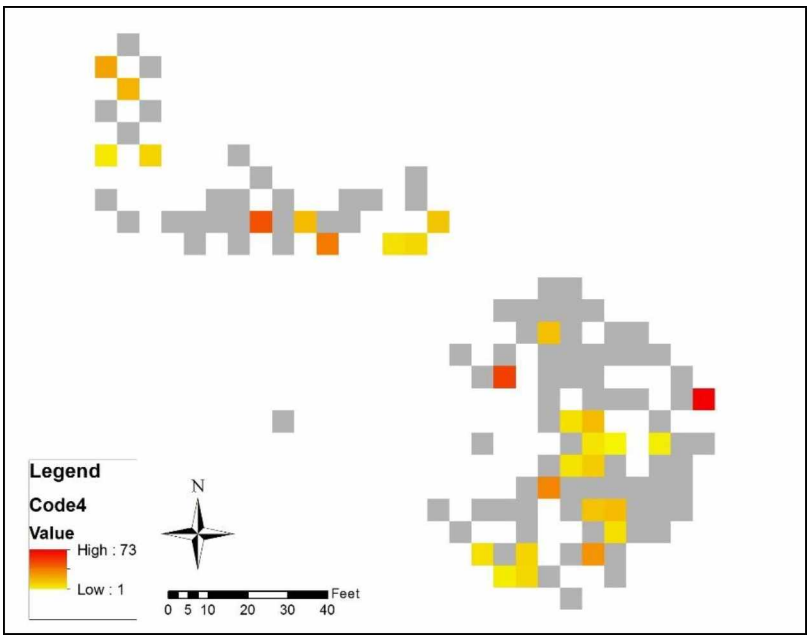

Figure 5-13. Distribution map of burn code 4. Values are depicted as percent of specimens (identifiable and unidentifiable) classified to a burn code present in a single block. Value can range from 0% (or no specimens in the blocks, gray colored squares) to 100% (or all specimens in the block, red colored squares).

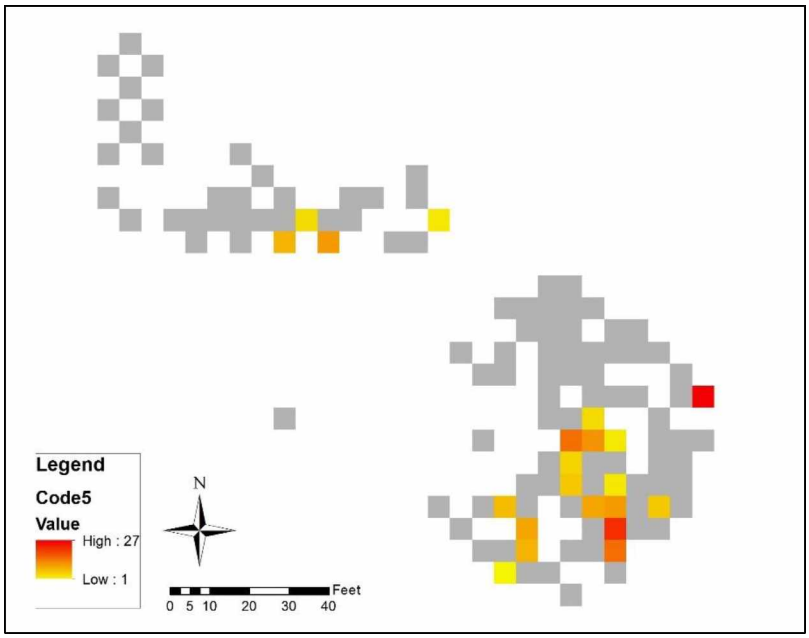

Figure 5-14. Distribution map of burn code 5. Values are depicted as percent of specimens (identifiable and unidentifiable) classified to a burn code present in a single block. Value can range from 0% (or no specimens in the blocks, gray colored squares) to 100% (or all specimens in the block, red colored squares).

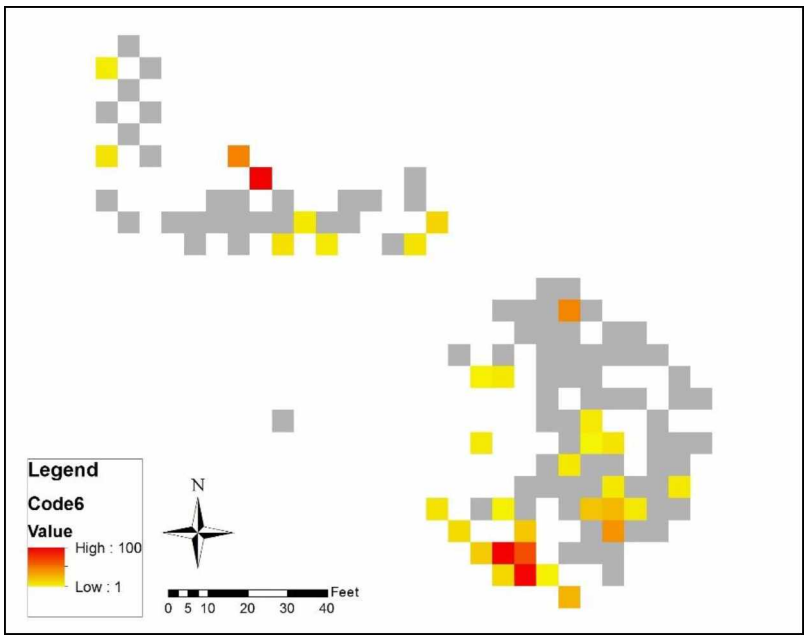

Figure 5-15. Distribution map of burn code 6. Values are depicted as percent of specimens (identifiable and unidentifiable) classified to a burn code present in a single block. Value can range from 0% (or no specimens in the blocks, gray colored squares) to 100% (or all specimens in the block, red colored squares).

5.5.2 Weathering

The Upper Cultural faunal collection from the Healy Lake Village site, which originated from the surface and within the first 10 in. (25.4 cm) of deposition, fell into three of Behrensmeyer's (1978) defined weathering codes (Table 5-10). Just over half of the assemblage (53.4%) showed no signs of weathering and the remaining half is unevenly distributed amongst the first three codes. There are 35 bones that were classified as unweathered by Behrensmeyer's coding system but which demonstrate external sun bleaching, which exhibits the limitations of this weathering classification code. I suspect that the absence of more extreme weathering is due to the short time frame the material was exposed on the surface, approximately 80 years between deposition and excavation.

Table 5-10. Weathering code list with count and percentage.

Weathering Code	Count	Percentage
0 (Unweathered)	2183	53.4%
1 (Cracking, Normally Parallel to Fiber Structure)	1514	37.0%
2 (Outermost Thin Layers Flaking)	329	8.0%
3 (All External Concentrically Layered Bone has been removed)	61	1.5%
TOTAL	**4087**	**100.0%**

5.5.3 Root Etching

The bulk of the faunal assemblage showed no evidence of root etching (87.3%), and, as Table 5-11 demonstrates, no specimens showed more than 30% root etching on the exterior surfaces. Similar to the weathering analysis, this pattern of root etching follows the expectations for this level. As previously stated, the material originated from the ground surface where root etching would be nearly absent, and in the root mat where extensive root damage can occur. As with weathering, the lack of more extensive root etching likely reflects the short time frame the material was buried.

Table 5-11. Root etching list with count and percentage.

Root Etching	Count	Percentage
0 (00%)	3566	87.3%
05 (5%)	483	11.8%
10 (10%)	28	0.7%
20 (20%)	3	0.1%
30 (30%)	2	<0.1%
77 (Not Applicable)	5	0.1%
TOTAL	**4087**	**100.0%**

5.5.4 Carnivore Damage

Though the site was hypothesized to have been disturbed due to the presence of a dog yard (Cook 1989), only ninety-two specimens (2.2% of the total collection) yielded carnivore damage. Looking at the distribution of carnivore damage between the two excavation areas, a majority of the damage originated from the southern excavation area (70 specimens), but this accounts for only 2.2% of the total remains in the southern excavation area (Figure 5-16). In the northern area, 22 bones yield evidence of carnivore damage, which accounts for 2.7% of the remains from that excavated area. However, the difference in the frequency of carnivore damaged bones is not statically significant ($\chi^2 = 0.572$, $p = 0.4495$). The cluster of carnivore damaged bone in blocks N20E15, N20E20 and N25E20 could indicate the presence of one dog tied up with a 5 ft. radius or; however, it could represent a discard pile since 326 bones (8% of the total collection) originates from those three blocks alone. I will address this cluster of bones further in Chapter 6.

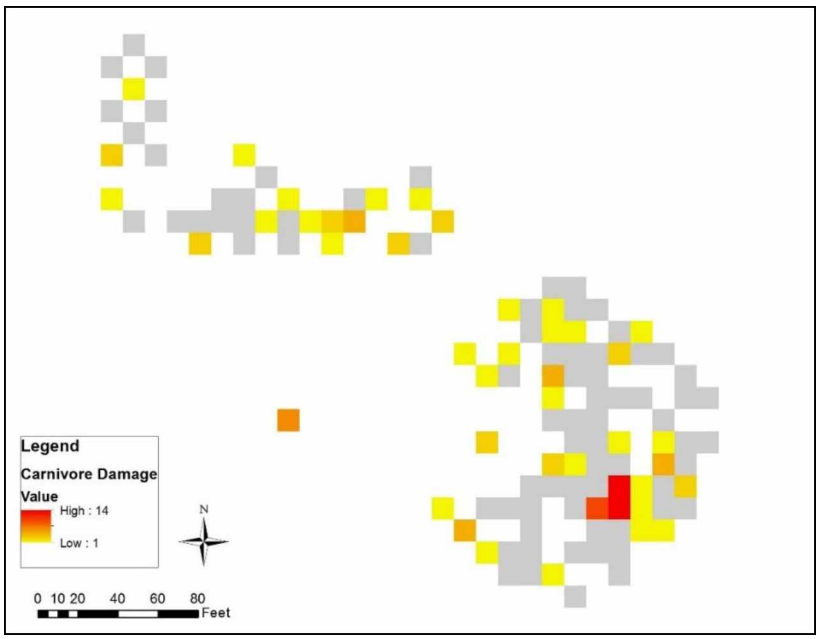

Figure 5-16. Distribution map of carnivore damaged specimens in the Upper Cultural layer. Values are depicted as number of specimens located in a single block. Identifiable and unidentified fragments are both depicted on the map.

Table 5-12. List of species and elements with carnivore damage.

Species and Elements with Carnivore Damage Present									
Anatomical Region	Skeletal Part	Moose	Caribou	Beaver	Medium	Large	Large/ Very Large	Very Large	Unident.
Axial	Thoracic Vertebrae	1	1						
	Lumbar Vertebrae		1						
	Ribs	8	6			2		3	
	Sacrum		1						
	Innominate	2			1	1	2	2	
Upper Front	Scapula	2	1					1	
	Humerus	5	2					1	
Lower Front	Radius-Ulna	1	3						
	Ulna	1							
Upper Hind	Femur	2	2	1					
Lower Hind	Tibia		2						
	Calcaneus	1	1	1					
	Astragalus		1						
Feet	Tarsals		1						
	Phalanges	6							
	Dew Claw	1							
	Unidentified					11	1		15
TOTAL		**30**	**22**	**2**	**1**	**14**	**3**	7	**15**

More than half of the bones with carnivore damage (54 bones) were identified as either moose, caribou or beaver (Table 5-12). All of the skeletal remains that have evidence of carnivore damage contain cancellous bone sections and would be appealing to dogs and other carnivores. Most of the damage is present on axial, upper forelimb, and foot elements. Ethnographically, innominates and scapulae were fed to dogs as food sources; however, ribs, humeri, and phalanges have more carnivore damage in the Upper Cultural assemblage. This could indicate that the carnivores were scavenging bones rather than being fed animal remains.

5.5.5 Cut Marks

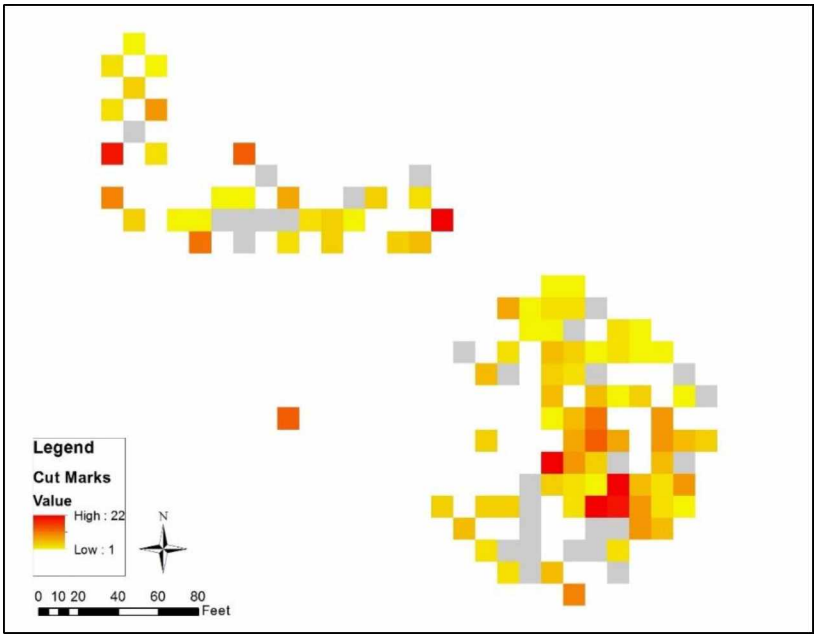

Figure 5-17. Distribution map of specimens with cut marks in the Upper Cultural layer. Values are depicted as number of specimens located in a single block. Identifiable and unidentified fragments are both depicted on the map.

In the Upper Cultural level, 9.1% of the assemblage has cut marks, 1.3% has scratches or cuts from the excavation, and 89.6% of all specimens show no cut marks. Looking at the distribution of cut marked specimens, 108 bones (12.8%) in the northern area bear cut marks, compared to 267 bones (8.2%) in the southern area (Figure 5-17). When statistically compared, the northern excavation area does show significantly more cut marks than the southern area, with a chi-square value of 16.55 and $p < 0.0001$. At least seven species show evidence of cut marks (Table 5-13). For moose, 130 bones bear cut marks; these are found on almost every skeletal element. The only elements that do not have cut marks but are present in the collection are the

hyoid bone, axis, cervical vertebrae, lateral malleolus, and astragalus. A similar pattern is apparent with the caribou, with 122 bones containing cut marks across almost all skeletal elements. The only bones that are present in the collection but do not have cut marks are the maxilla, axis, sesamoids, indeterminate vertebrae. For both moose and caribou, cut marks are most frequently found on rib bones, followed by the tibia and innominates for moose and the femur and radius-ulna for caribou. Only 15 bones that are not moose or caribou bear cut marks. Given that cut marks are present on almost every skeletal element for moose and caribou, all forms of processing activities (skinning, filleting, dismemberment, and consumption) appear present in the assemblage.

Table 5-13. List of species and elements list with cut marks.

Species and Elements with Cut Marks Present									
Skeletal Part	Moose	Caribou	c.f. Caribou	c.f. Porcupine	Dog	Beaver	Lynx	Dall's Sheep	Red Fox
Cranium	5	3						1	
Antler		1							
Maxilla	1								
Mandible	8	2			1				
Hyoid									
Atlas	2					1			
Axis									
Cervical Vertebrae		1							
Thoracic Vertebrae	4	6							
Lumbar Vertebrae	1	2							
Caudal Vertebrae									
Vertebrae									
Ribs	20	20				1			
Sternum									
Scapula	3	6				1			
Humerus	8	4	1			1			
Radius-Ulna	3	9							
Radius	5	5		1		1			
Ulna	1	4							
Metacarpal	6	3							
Carpals	6	3							
Innominate	11	3							
Sacrum	1	1							
Femur	5	11				1			1
Patella	1						1		
Tibia	13	7				1	1		
Lateral Malleolus		2							
Metatarsal	5	8							
Calcaneus	1	7							
Astragalus		2							

Species and Elements with Cut Marks Present									
Skeletal Part	Moose	Caribou	c.f. Caribou	c.f. Porcupine	Dog	Beaver	Lynx	Dall's Sheep	Red Fox
Tarsals	6	2							
Metapodials	2								
Phalanges	9	8				1			
Dew Claw	2	2							
Sesamoids	1								
TOTAL	**130**	**122**	**1**	**1**	**1**	**8**	**2**	**1**	**1**

5.5.6 Other Taphonomic Variables

Eleven other taphonomic signatures were identified on the Upper Cultural fauna, each identified on less than 1% of the total collection (Table 5-14). Five of these taphonomic variables are human derived (percussion marks, drilling, grooving, saw cut, and worked bone), whereas the others are non-anthropogenic (rodent damage, acid etching, pitting, trampling, and water polishing).

Table 5-14. List of other taphonomic variables.

Other Taphonomy	Count	Percentage
Percussion Marks	3	0.07%
Rodent Damage	2	0.05%
Acid Ethcing	2	0.05%
Drilled	1	0.02%
Grooved	1	0.02%
Pitting	1	0.02%
Saw Cut	1	0.02%
Trampling	1	0.02%
Water Polish	2	0.05%
Worked	3	0.07%

5.6 Density Mediated Attrition

Before looking to the elemental data, it is first important to explore whether or not the assemblage was impacted by density mediated attrition. When plotting nNISP against Lam et al.'s (1999) density values for the entire site, there is a statistically significant relationship between abundance and bone density for moose (Figure 5-18) but not for caribou remains (Figure 5-19). The results from the Spearman's Ranked Correlation Coefficient and Kendall's tau-b tests show that moose remains have a significant, positive correlation to bone density ($p=0.0012$ and $p=0.0018$ respectively; Table 5-15). Caribou, on the other hand, yielded values of $p=0.0820$ for Spearman's Ranked Correlation Coefficient and $p=0.0854$ for Kendall's tau-b

(Table 5-15), indicating that there is not a significant relationship between frequency and density. This difference could be due to processing, carcass transport decisions, difference in bone fragmentation between animal body size (Yeshurun et al. 2007), or other factors that will be discussed further in Chapter 6.

Next, I separated the site into the two excavation areas, north and south, and re-ran the statistical tests for both moose and caribou (Figures 5-20, 5-21, 5-22, and 5-23). The results showed that there is a positive correlation between element frequency and structural density for moose remains in the south area with significance values of p=0.0032 for Spearman's Ranked Correlation Coefficient and p=0.0060 for Kendall's tau-b, but no significant correlation in the northern area (p=0.4417 for Spearman's Ranked Correlation Coefficient and p=0.4121 for Kendall's tau-b; Table 5-16). Caribou showed a similar pattern (Table 5-16) in that there appears to be no correlation between caribou remains and density in the north area of the site. While there is a significant correlation between frequency and density in the south area using Spearman's Ranked Correlation Coefficient (p = 0.0490), the relationship between element frequency and density in the south is not significant using Kendall's tau-b (p = 0.0672). As stated in Chapter 4, Kendall's tau-b is likely more accurate for this analysis since it is preferred when there are numerous tied ranks within a small data set, suggesting that the caribou assemblage is not significantly impacted by density mediated attrition in either excavation area.

Table 5-15. Statistical results for the density mediated attrition analysis for the entire site. Statistically significant values are indicated in red.

Species	Variable	By Variable	Spearman p	Prob>|p|	Kendall's τ	Prob>|τ|
Moose	nNISP	Density	0.3352	0.0012	0.2290	0.0018
Caribou	nNISP	Density	0.1875	0.0820	0.1285	0.0854

Table 5-16. Statistical results for the density mediated attrition analysis for moose and caribou separated by excavation area. Statistically significant values are indicated in red.

Species	Site Area	Variable	By Variable	Spearmans p	Prob>|p|	Kendall's τ	Prob>|τ|
Moose	North Area	nNISP	Density	0.1059	0.4417	0.0847	0.4121
Moose	South Area	nNISP	Density	0.3109	0.0032	0.2065	0.0060
Caribou	North Area	nNISP	Density	0.1232	0.2956	0.0880	0.2831
Caribou	South Area	nNISP	Density	0.2182	0.0490	0.1439	0.0672

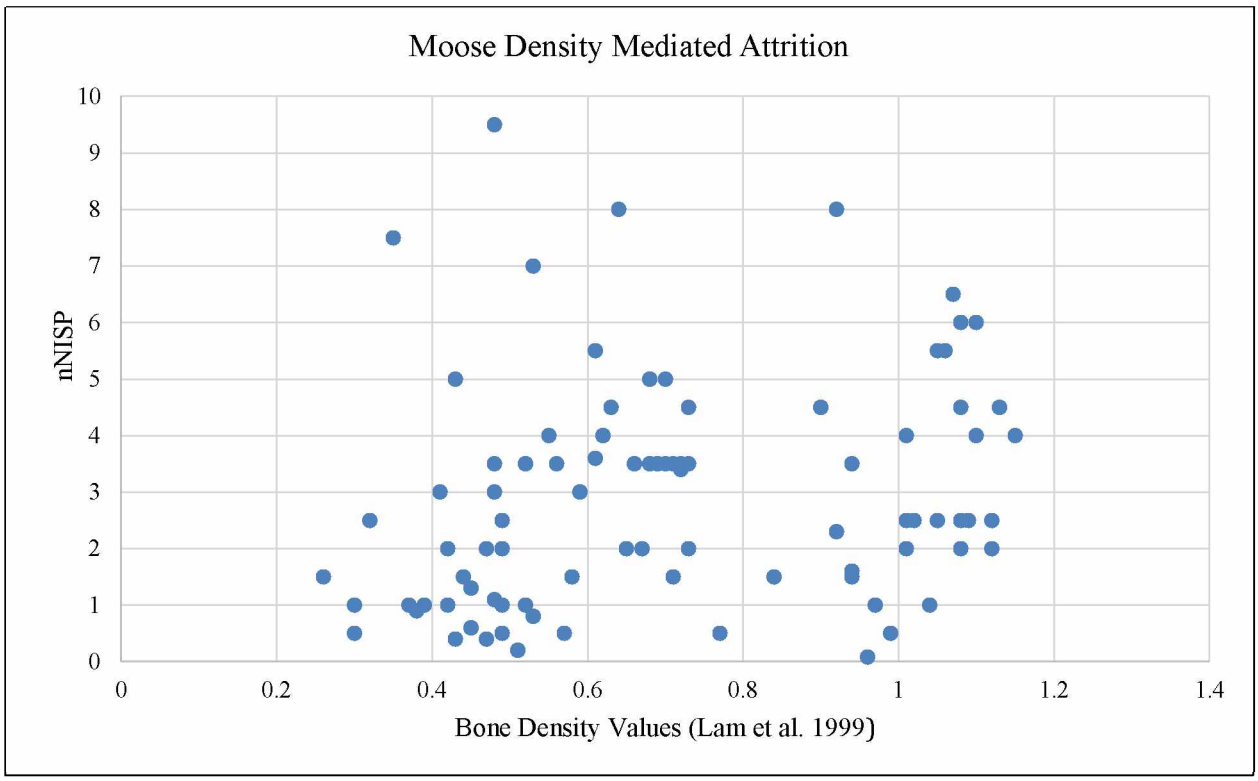

Figure 5-18. Scatterplot of moose bone density values against nNISP for entire site.

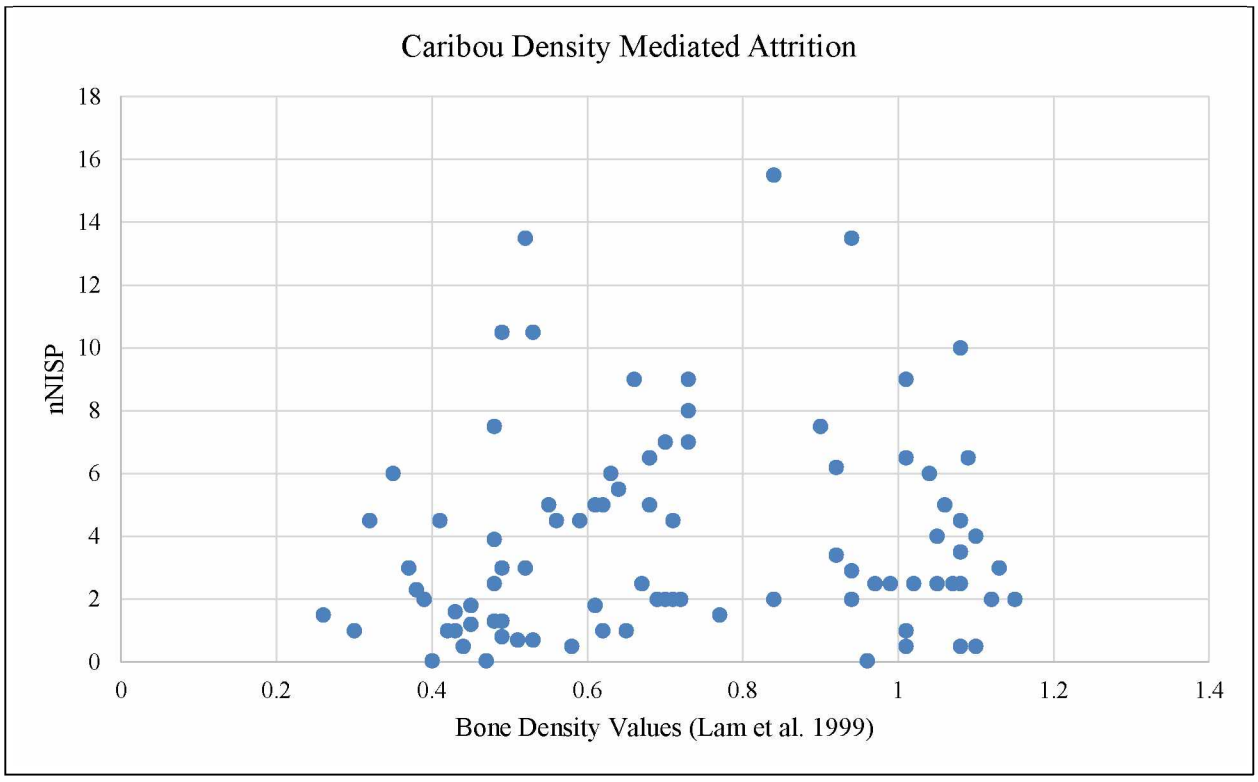

Figure 5-19. Scatterplot of caribou bone density values against nNISP for entire site.

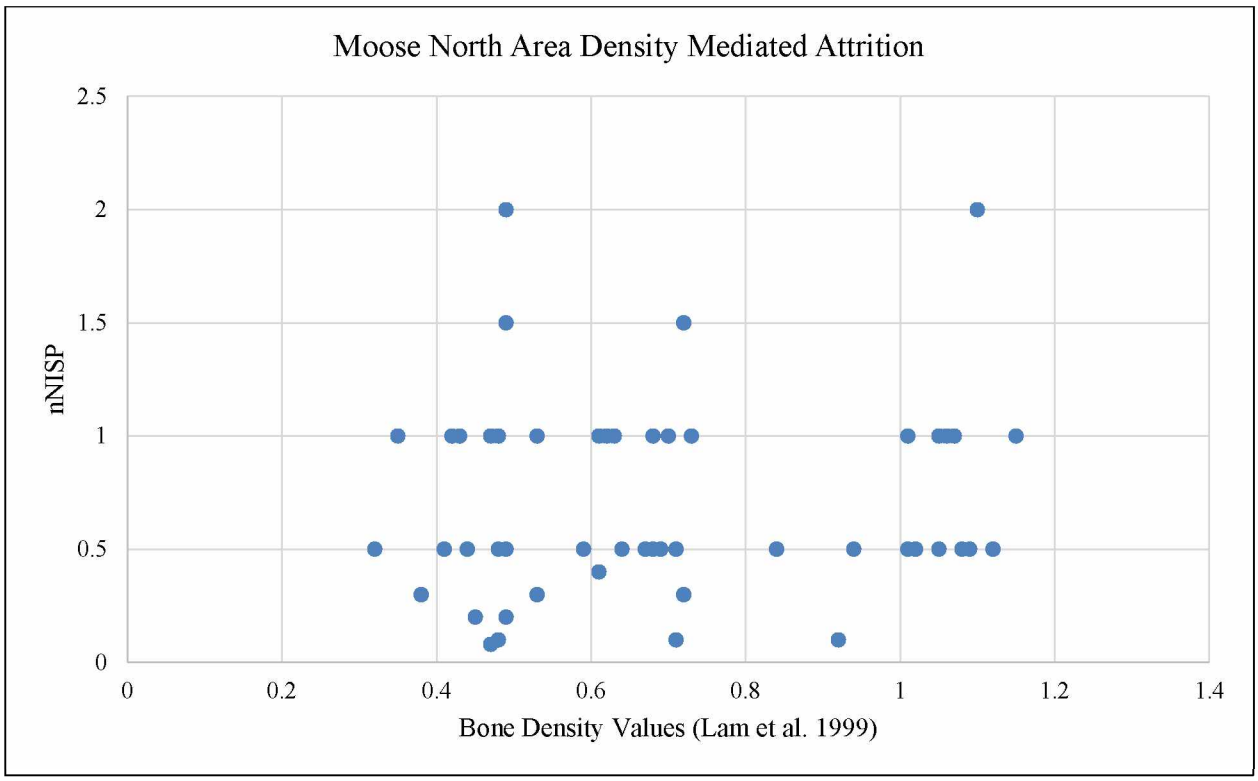

Figure 5-20. Scatterplot of moose bone density values against nNISP for the northern excavation area.

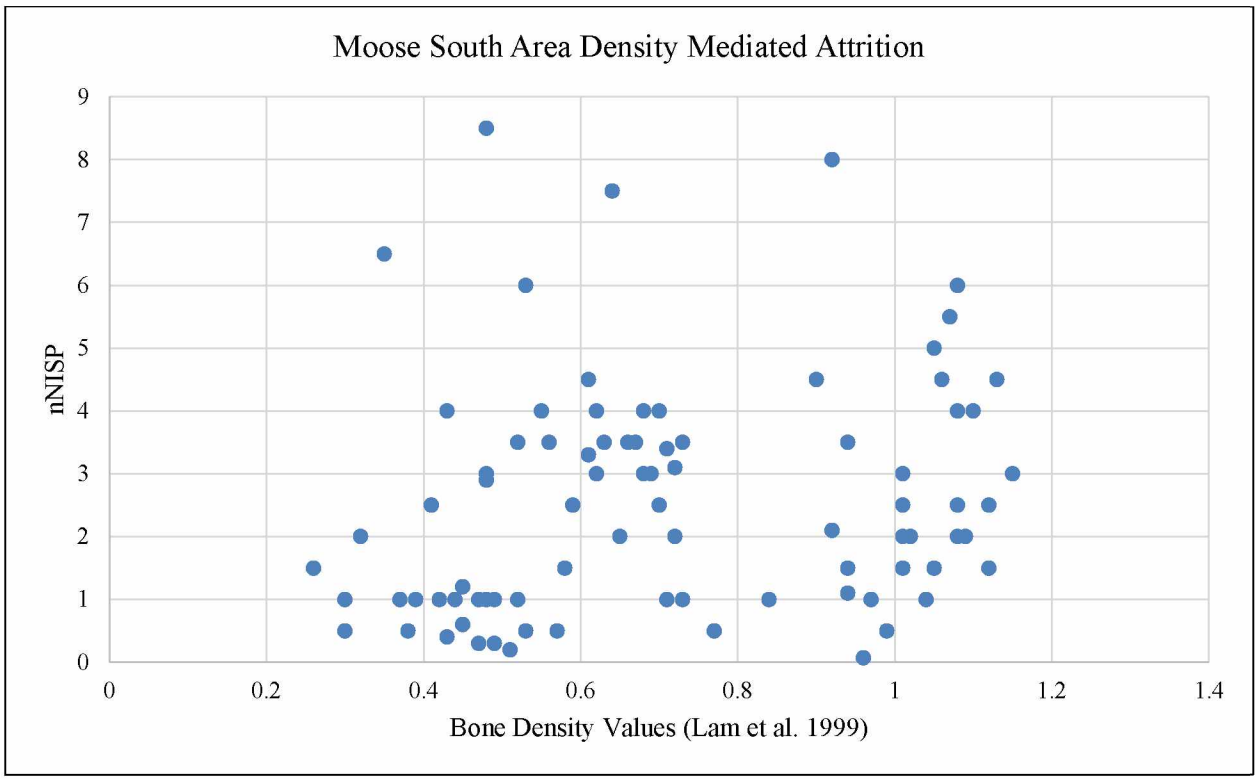

Figure 5-21. Scatterplot of moose bone density values against nNISP for the southern excavation area.

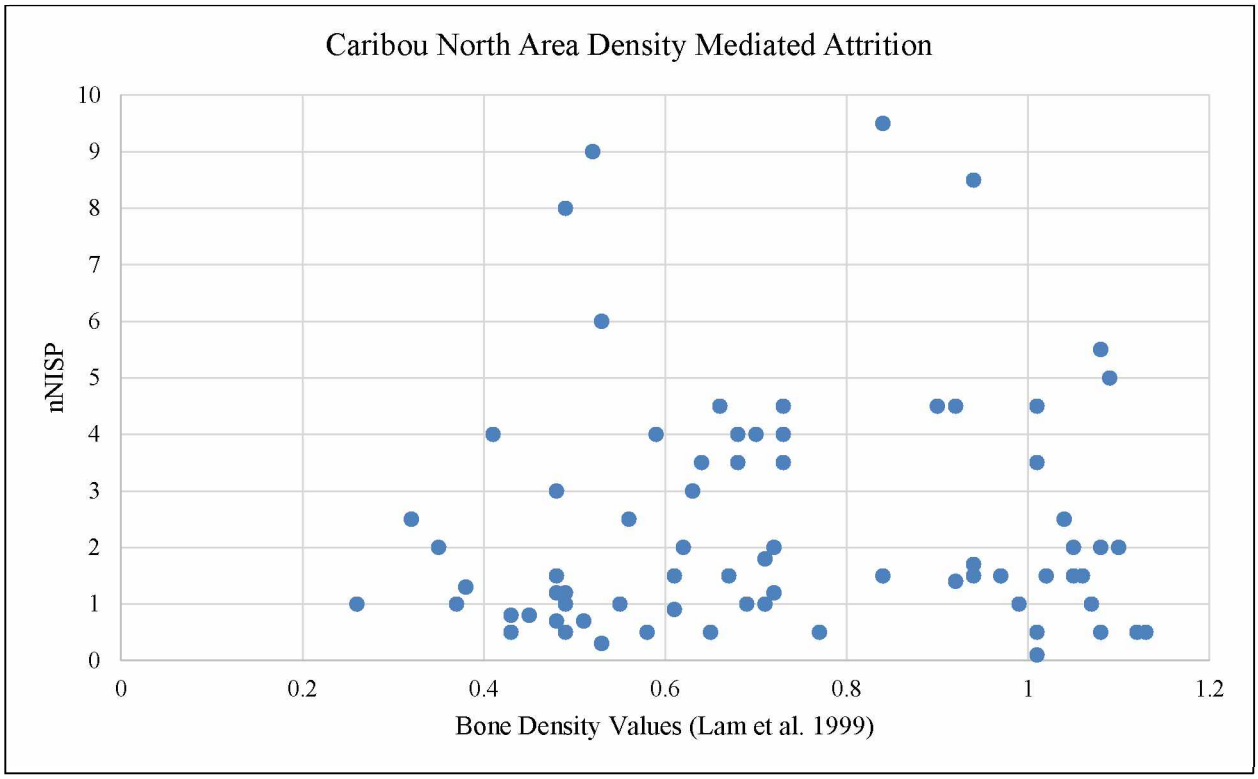

Figure 5-22. Scatterplot of caribou bone density values against nNISP for the northern excavation area.

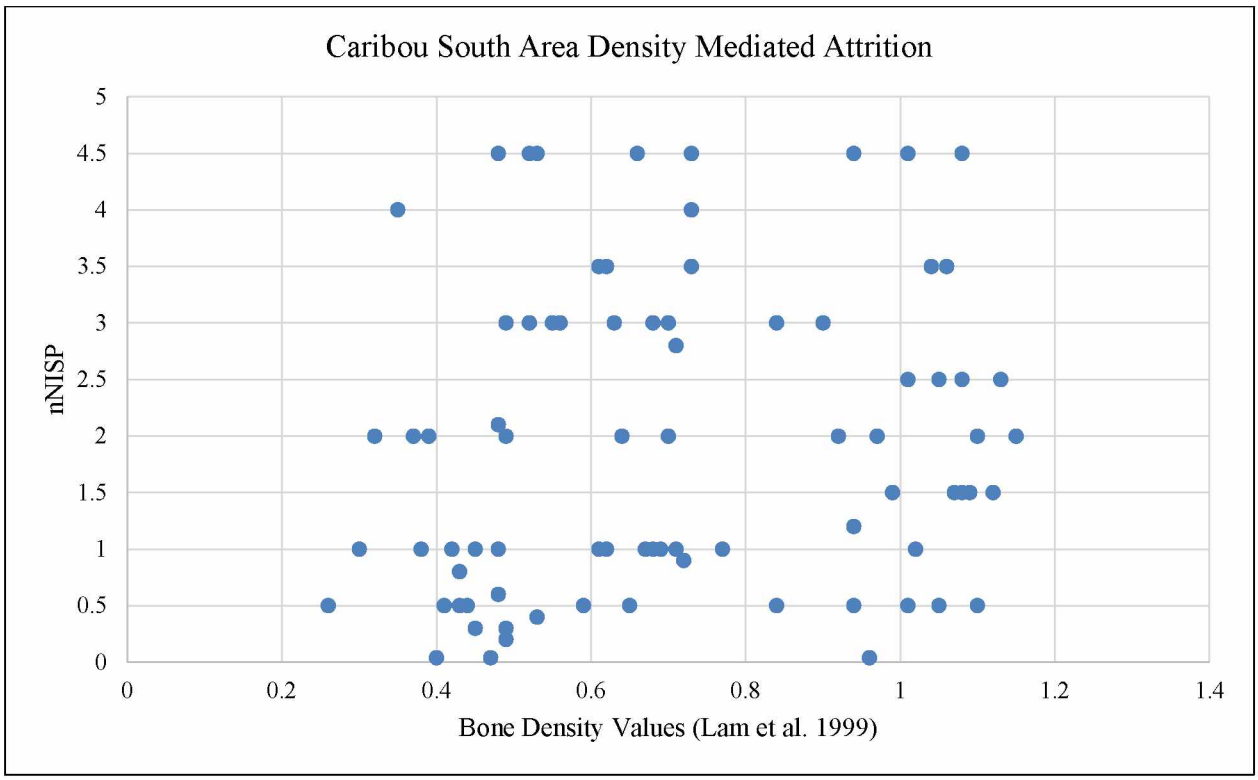

Figure 5-23. Scatterplot of caribou bone density values against nNISP for the southern excavation area.

5.7 Elemental Data

5.7.1 Fragmentation

Once I calculated the NISP and MNE values for caribou and moose (See Appendix C for element data for every taxa, including species that could only be identified to the closest species [cf.]), I was able to assess the degree of fragmentation using three different methods. The first way is by comparing NISP values to MNI and MNE values (Todd and Rapson 1988). The NISP: MNI analysis yielded 54 bones per identifiable caribou (759:14) and 89 bones per identifiable moose (626:7), indicating that moose bones are more fragmented than caribou. The NISP: MNE ratios for both caribou and moose showed 2 fragments per identifiable bone (708:370 ratio for caribou and 524:287 ratio for moose), suggesting that the intensity of fragmentation is the same for both species. Another way of exploring fragmentation is by comparing complete versus fragmented carpals and tarsals, which, as mentioned earlier, assesses the degree of post-depositional destruction since these bones tend to not be fragmented by human or animal activities (Marean 1991). This resulted in a completeness index of 68.63% for caribou since there are a total of 51 carpals and tarsals and 35 were complete. Moose yielded a completeness index of 84.91% with 45 complete carpals and tarsals out of the 53 identified. By combining these results, an interesting pattern emerges. The NISP: MNI ratio indicates that moose are more fragmented than caribou, and to take it a step further, the completeness index suggests that moose bone fragmentation is more likely to be caused by human activity and that caribou bones could have been more fragmented post-depositionally. However, the overall intensity of fragmentation from human activities versus post-depositional factors appear to have been similar.

5.7.2 Element Frequency

As Figure 5-24 demonstrates, moose and caribou have a similar distribution of elements, though there are some discrepancies, such as that caribou have more maxillae, radius-ulnas, ulnas, and lateral malleoli, whereas moose have more atlases, humeri, metacarpals, and dew claws. (See Appendix C for %MAU values for all other species).

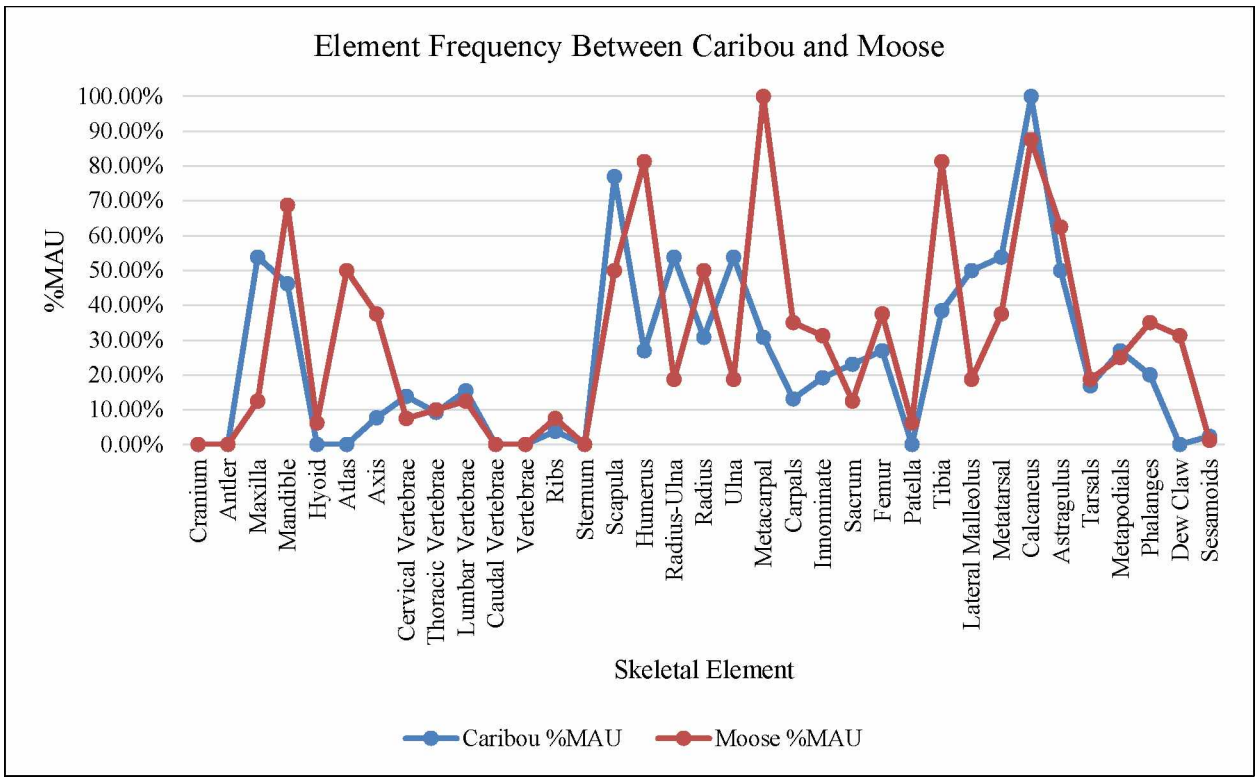

Figure 5-24. Element frequency graph comparing caribou and moose remains.

5.7.3 Caribou and Moose Elemental Distribution between Excavation Areas

Since the previous analyses have shown different patterns between the two excavation areas, I decided to explore how the distribution of elements for moose and caribou varies across the two excavation areas (Figure 5-25 and 5-26).

The distribution of elements for moose shows an uneven pattern between the north and south areas of the site (Figure 5-26). There are elements from all anatomical units in both excavation areas, but they appear in different quantities. The elements that appear in greater abundance in the northern area are the atlas, thoracic vertebras, carpals, innominate and femur. This distribution pattern could reflect the impact of density mediated attrition. As mentioned earlier in this chapter, there is a correlation between survivorship and bone density for moose remains in the southern excavation area but not the north. All of the elements that are more abundant in the southern area (i.e. mandible, humerus, metacarpal, and tibia) are considered denser bones; however, they are also some of the higher marrow yielding elements (Binford 1978).

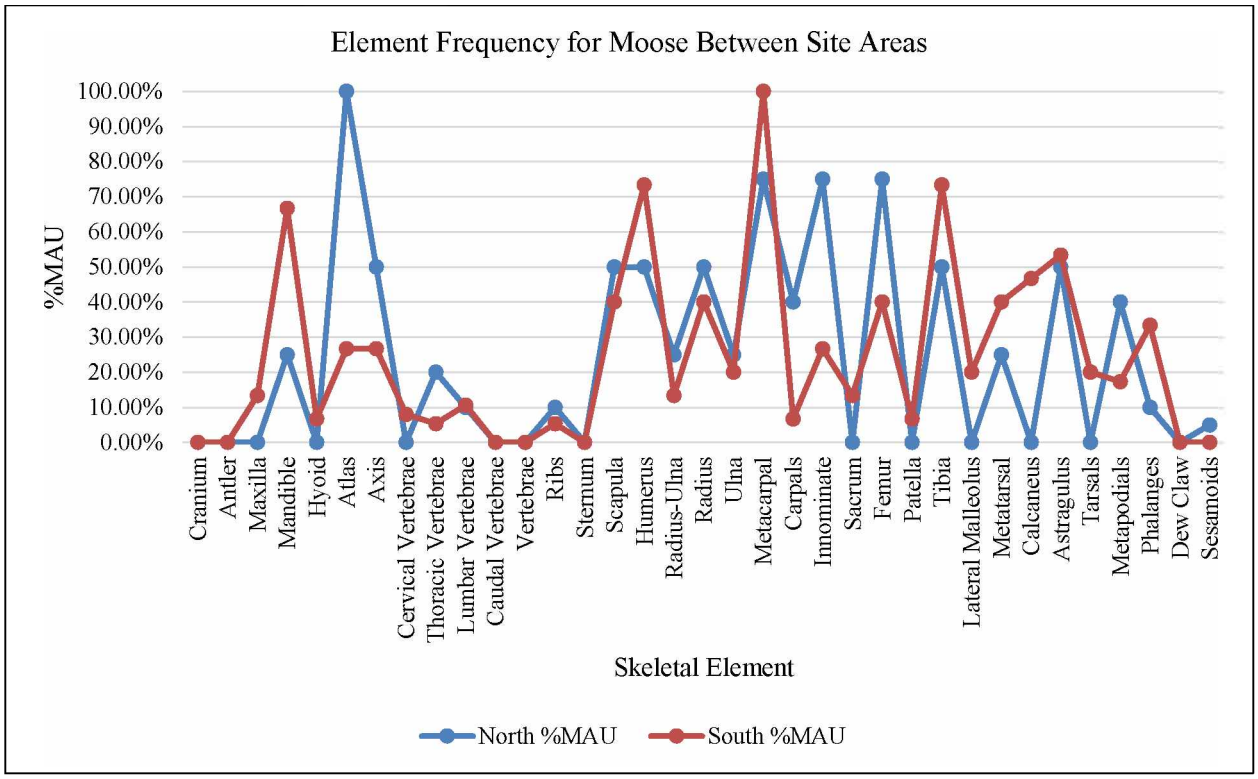

Figure 5-25. Element frequency graph comparing excavation areas for moose remains.

As demonstrated in Figure 5-26, caribou elements appear to follow a similar pattern for both the excavation areas; however, there are a few differences. In the southern area of the site, there are fewer fore-limb elements and calcanei than the north, but a larger number of maxillae, mandibles, scapulae, and lateral malleoli. This pattern is likely a reflection of human behavior and carcass processing since caribou remains did not show a difference in density mediated attrition. In addition, the overall low frequency of vertebrae and ribs could suggest that those sections were being brought to other areas of the site for processing, traded/ sold to miners, as food supplies for hunting trips, or stored for later consumption. All of these explanations will be explored and discussed further in Chapter 6.

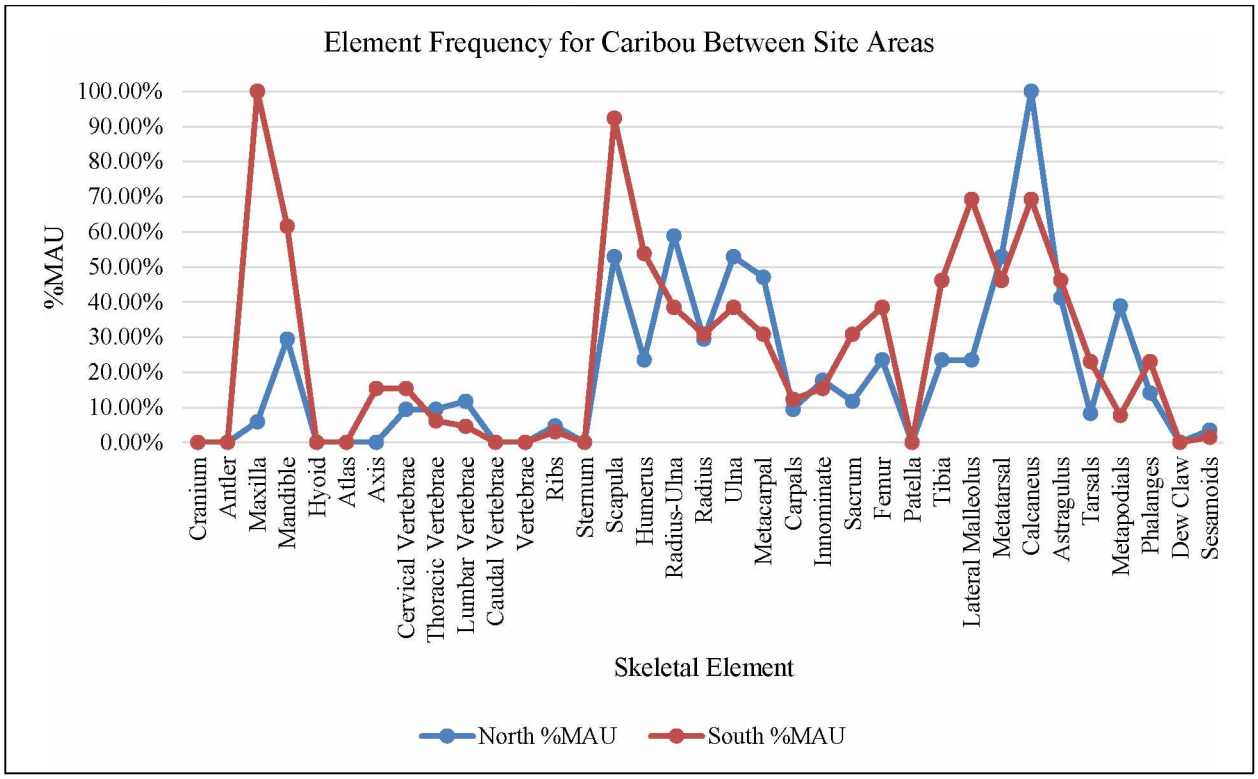

Figure 5-26. Element frequency graph comparing excavation areas for caribou remains.

5.7.4 Long Bone Epiphyses versus Long Bone Shaft Distribution

Long bone shafts and long bone ends are generally treated differently among Native Alaskan communities (Binford 1978, 1981; Haynes and Simeone 2007; McKennan 1959). Unfortunately, shaft fragments and epiphyses are also treated differently by carnivores, such as dogs (Marean and Spencer 1991); however, since carnivore damage was not prevalent in the assemblage, it can be assumed that any difference in distribution was caused by human behavior. As demonstrated by the distribution maps, long bone epiphyses appear throughout both excavation areas (N = 150, 17.8% of the northern remains and S = 220, 6.8% of the southern remains) (Figure 5-27); however the epiphyses are significantly more common in the northern excavation area (χ^2 = 36.043 and p <0.0001). In contrast, shaft fragments are more abundant in the southern area (N = 95, 11.3% of the northern remains and S = 552, 17.0% of the southern remains) (Figure 5-28) and are significantly more common in the southern excavation area (χ^2 = 21.525, p <0.0001). Given the statistically significant relationship between element abundance and bone density in the south, this result is not surprising. Long bone shafts are significantly denser than their epiphyseal counterparts and tend to survive trampling and other post-

depositional factors better, which is what would be expected at a site with density mediated attrition.

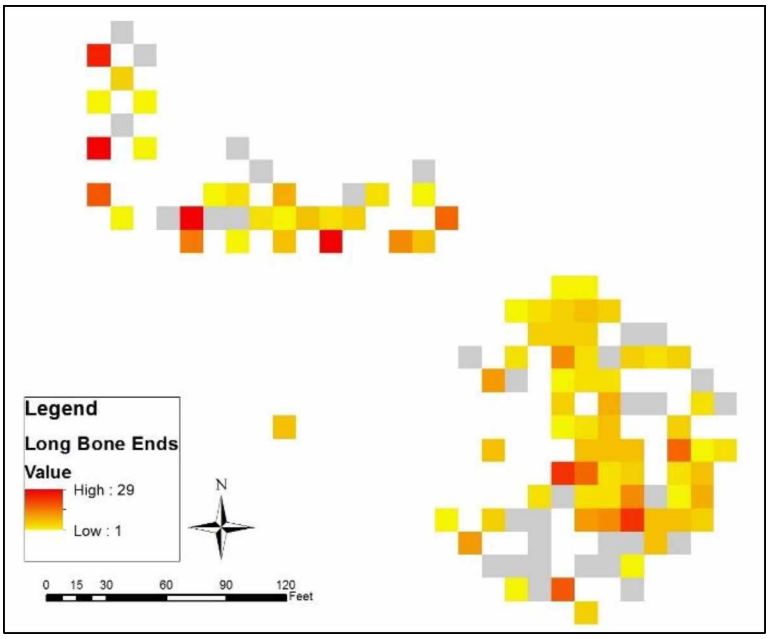

Figure 5-27. Spatial distribution of long bone epiphyseal fragments. Values are depicted as number of identified specimens located in a single block.

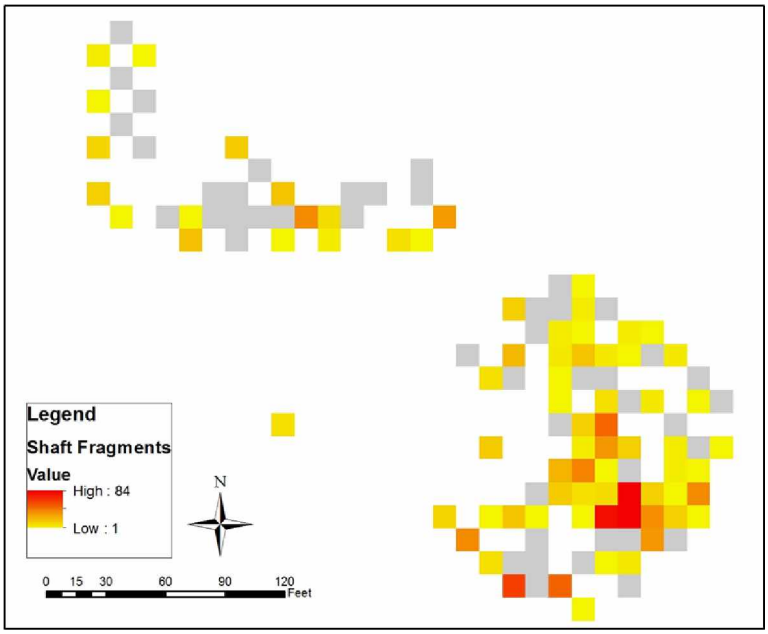

Figure 5-28. Spatial distribution of long bone shafts fragments. Values are depicted as number of identified specimens located in a single block.

5.8 Age Profile

Very few bones derive from juvenile individuals (Table 5-17). Eighty-nine specimens or 2.2% of the collection are unfused and 18 specimens (0.4%) are partially fused. Of the remaining bones (546 bones, or 13.4% of the assemblage), were completely fused, while fusion status could not be assessed for the remainder because the proximal or distal end was not present (3434 of 84.0%).

Table 5-17. Epiphyseal fusion code list with count and percentage.

Epiphyseal Fusion Codes	Count	Percentage
0 (Unfused)	89	2.2%
1 (Partially Fused)	18	0.4%
2 (Completely Fused)	546	13.4%

For the two primary species, I identified 23 unfused moose specimens (3.70% of all moose bones) and 44 unfused caribou bones (5.80%) (Table 5-18). For moose, there are 3 unfused vertebrae and 1 unfused innominate identified in the assemblage, and the remaining unfused bones were limb bones. As stated earlier, there is no comparative modern data to correlate fusion status with age for moose, so I will not be able to discuss this further. Conversely, the majority of the unfused caribou bones are vertebrae, not limb elements. The unfused caribou elements suggest that there are two specimens that are between the ages of 2-6 months, two between the ages of 6-15 months, two between 18-42 months, six between 36-48 months, one specimen between 42-54 months of age, and 30 vertebrae specimens indicating individual(s) ≥45 months. I will explore the age profile of caribou further in Chapter 6 in order to evaluate seasonality of occupation and hunting practices.

Table 5-18. Unfused element list for moose and caribou with count and percent of total remains for each species.

Unfused Elements			
Skeletal Part	Moose	Caribou	**Age**
Cervical Vertebrae (2-5)		2	45-? mo
Thoracic Vertebrae		14	45-? mo
Lumbar Vertebrae	3	4	45-? mo
Vertebrae		10	45-? mo
Scapula		2	2-6 mo
Humerus			
Proximal	2	2	42-54 mo
Distal		1	6-15 mo
Radius-Ulna		1	18-30 mo

Unfused Elements			
Radius			
Proximal			4-10 mo
Distal	1	1	36-48 mo
Metacarpal			
Distal	3		18-30 mo
Innominate	1		2-15 mo
Sacrum		1	35-42 mo
Femur			
Proximal	4	1	36-48 mo
Distal	1	1	36-48 mo
Tibia			
Proximal	1	2	36-48 mo
Distal	4		18-30 mo
Metatarsal			
Distal	1		18-30 mo
Calcaneus		2	18-42 mo
Metapodials			
Distal	1		18-30 mo
TOTAL	**22**	**44**	
Percent of Total for Each Species	**3.70%**	**5.80%**	

5.9 Utility Indices

Table 5-19. Results of utility index analyses for caribou and moose remains. Statistically significant values are indicated in red.

Species	Variable	By Variable	Kendall's τ	Prob> |τ|
Caribou	nNISP	MUI (g)	0.0438	0.7775
		MUI (g)*	0.0438	0.7775
	nNISP	FUI	-0.0593	0.7413
	nNISP	CFUI	0.1645	0.2635
		CFUI*	0.1499	0.3083
	nNISP	Grease	0.2194	0.1360
	nNISP	UMI (ml)	0.8092	0.0003
	nNISP	MDI	-0.2889	0.0621
Moose	nNISP	MUI (g)	-0.1046	0.4981
		MUI (g)*	-0.0959	0.5345
	nNISP	FUI	-0.1926	0.2833
	nNISP	CFUI	-0.0292	0.8425
		CFUI*	-0.0365	0.8039
	nNISP	Grease	0.2518	0.0866
	nNISP	UMI (ml)	0.5649	0.0110
	nNISP	MDI	-0.3312	0.0319

* Indicates that the analysis was tested using the half value for cranium in order to take into account sides
**.05 Sig.

The comparison of nNISP values for caribou and moose to the different utility indices yielded interesting patterns. The caribou remains show a strong positive correlation to the unsaturated marrow index, with p = 0.0003 (Table 5-19). There is no correlation between caribou remains and the general food index, corrected food index, grease index, or dried meat index.

As for moose, two indices yielded statistically significant correlations to remains present at Healy Lake Village site. The first is a positive correlation to the unsaturated marrow index, with p = 0.0110, and the second is a negative correlation to the dried meat index, with p = 0.0319.

Table 5-20. Results of utility index analyses for caribou remains for the two excavation areas. Statistically significant values are indicated in red.

Species	Variable	By Variable	Kendall's τ	Prob> |τ|
Caribou North	nNISP	MUI (g)	-0.0530	0.7340
		MUI (g)*	-0.0442	0.7771
	nNISP	FUI	-0.0967	0.5914
	nNISP	CFUI	0.0889	0.5498
		CFUI*	0.0815	0.5835
	nNISP	Grease	0.1336	0.3696
	nNISP	UMI (ml)	0.6565	0.0031
	nNISP	MDI	-0.2561	0.1005
Caribou South	nNISP	MUI (g)	0.0976	0.5328
		MUI (g)*	0.0798	0.6098
	nNISP	FUI	0.1914	0.2990
	nNISP	CFUI	0.2041	0.1703
		CFUI*	0.1744	0.2413
	nNISP	Grease	0.2196	0.1513
	nNISP	UMI (ml)	0.7813	0.0005
	nNISP	MDI	-0.2484	0.1123

* Indicates that the analysis was tested using the half value for cranium in order to take into account sides
**.05 Sig.

Since most of the other results indicate a difference between species and element abundances, as well as taphonomic differences, between the north and south excavation areas, I decided to test if there are also differences in the utility indices for both caribou and moose from the northern versus southern areas. In both the north and south excavation areas, caribou remains are significantly correlated with the unsaturated marrow index (p = 0.0031 for the north and p = 0.0005 for the south) (Table 5-20). The moose remains from the northern excavation area are not significantly correlated with any index, whereas the moose remains in the southern excavation

area are positively correlated to marrow (p = 0.0161), and negatively correlated to the meat drying index (p = 0.0084) (Table 5-21). These results could indicate that caribou marrow processing occurred throughout the site and moose meat drying potentially occurred solely in the southern excavation areas, with dried the sections later removed yielding the negative relationship. However, the negative correlation to meat drying could also reflect density mediated attrition, since the elements that rank high for drying (i.e., ribs and vertebrae) are also less dense.

Table 5-21. Results of utility index analyses for moose remains for the two excavation areas. Statistically significant values are indicated in red.

Species	Variable	By Variable	Kendall's τ	Prob>|τ|
Moose North	nNISP	MUI (g)	0.0091	0.9544
		MUI (g)*	0.0000	1.0000
	nNISP	FUI	-0.1793	0.3349
	nNISP	CFUI	0.0910	0.5470
		CFUI*	0.0683	0.6515
	nNISP	Grease	-0.0038	0.9800
	nNISP	UMI (ml)	0.4186	0.0622
	nNISP	MDI	-0.1460	0.3598
Moose South	nNISP	MUI (g)	-0.1638	0.2942
		MUI (g)*	-0.1815	0.2451
	nNISP	FUI	-0.1791	0.3209
	nNISP	CFUI	-0.0481	0.7460
		CFUI*	-0.0629	0.6719
	nNISP	Grease	0.1808	0.2226
	nNISP	UMI (ml)	0.5344	0.0161
	nNISP	MDI	-0.4116	0.0084

* Indicates that the analysis was tested using the half value for cranium in order to take into account sides
**.05 Sig.

5.10 Results Summary Statement

The Upper Cultural assemblage is dominated by large and very large mammals, which could reflect the inhabitants' choices or a result of excavation procedures (with a lack of screening causing the underrepresentation of smaller animals). One of the most interesting patterns that revealed itself during analysis is the fact that there are a number of differences between the north and south excavation areas. These differences include variation in the distribution of species and skeletal elements, and taphonomic variables. They could indicate separate behavioral choices. In the next chapter I will discuss these results in reference to my

research questions in order to situate the Healy Lake Village site faunal assemblage within regional models of historic land use and trade patterns.

Chapter 6 Discussion and Conclusions

This chapter will discuss the results in reference to the research questions, followed by possible avenues for future work.

6.1 Discussion of Results

6.1.1 Taphonomy and Preservation

Before addressing the broader questions about human behavior and site use at the Healy Lake Village site, it is necessary to assess if, and to what degree, the Upper Cultural faunal assemblage was affected by density mediated attrition, as this could bias the assemblage and skew any resulting interpretations. As stated in Chapter 5, density mediated attrition is present in varying levels depending on species and location at the site. At the site level, the presence of moose remains is positively correlated to bone density, but this is not the case for caribou. Once the site is broken into the two excavation areas, the moose remains appear to primarily be affected by density mediated attrition in the southern excavation area but not in the north.

These patterns could be explained by natural factors (i.e. trampling and carnivore destruction) and human behavior (i.e. transportation decisions and processing practices). Moose are larger in size than caribou and their remains could be more susceptible to trampling since they have larger surface areas (Yeshurun et al. 2007). However, the fragmentation analysis indicates that moose were less affected by post-depositional destruction than caribou. Moose remains also yielded more carnivore damage than any other species in the assemblage. Since carnivores preferentially consume spongy bone, this could cause the moose remains to be more affected by density mediated attrition than the caribou remains. However, given that only 30 bones show this damage, carnivore activity is probably not the primary driver of density mediated attrition.

Given this, these patterns are more likely a reflection of human activity. The ethnographic record suggests that moose were typically hunted by three to four hunters on single day trips while caribou were hunted as part of longer trips with multiple people to aid in processing and carrying the remains back to camp (McKennan 1959; Vitt 1971). The simple difference in the number of individuals available to carry sections back to camp could impact processing/transport choices; however, it has been documented that if a moose is killed a great distance from camp, i.e., too far for the hunters to transport, they would leave the carcass, return

to camp, and recruit more people to transport the resources (Vitt 1971). To make sure that "little of the animal was wasted," it was common practice to section whole carcasses and bring everything back to camp (Vitt 1971: 157). Hides would have been made into clothing or cut into snare lines, meat and organs were cooked and consumed as food, and bones were brought back to be rendered for bone grease and marrow (McKennan 1959; Vitt 1971). Second, when the animals were hunted, the Healy Lake inhabitants had access to sleds, dogs, and other modes of transportation, so the number of people, weight of the meat, and other transportation decisions would likely not have been a major deciding factor.

The assemblage could also have been biased in favor of dense bones through their processing choices. The larger moose remains might have been broken down further in order to fit cooking space or to acquire the marrow and grease, whereas caribou bones might not have needed to be processed as intensely for cooking (Yeshurun et al. 2007). This could cause the moose epiphyseal ends to be selectively destroyed, leaving more dense cortical sections.

The fragmentation analysis can further shed light on the driving factors for the density mediated attrition pattern present at the Healy Lake Village site. The NISP:MNI ratios suggests that moose bones are more fragmented than caribou, the NISP:MNE ratios suggests that the intensity of fragmentation is the same for both species, and the completeness index showed that caribou suffered greater post-depositional destruction than moose. Not that although NISP:MNI ratio addresses how fragmented the remains are the collection, this type of analysis can also be biased by differential transportation decisions since higher ratios could indicate that animals were brought back more complete (Marshall and Pilgram 1993; Todd and Rapson 1988).

Unfortunately, density mediated attrition can be caused by many factors which cannot be fully parsed apart at this time. The most likely diving forces for the density mediated attrition evidencet here is a combination of human activities, driven by processing or transportation decisions, for moose remains. It is also important to reiterate that the density mediated attrition analysis for moose was conducted using caribou density values, as moose bone densities have yet to be established.

The main taphonomic variables that were used to assess preservation of the remains are weathering, burning, root etching, and carnivore damage. Weathering, or the exposure to the environment, can cause bones to crack, split, and decompose (Behrensmeyer 1978). As expected, the faunal assemblage was affected by varying degrees of weathering. As stated in Chapter 5, the

level of weathering observed correlates with duration of exposure. The bones were excavated from the surface and sod layers of the site, which, as Behrensmeyer (1978) described, could yield material ranging from no weathering to heavily weathered material. Burning can also cause bones to become brittle, crack or even become chalky in the case of calcined bones, leading to a large portion of the collection to be unidentifiable. Root etching, in the past, has not necessarily been correlated to survivorship of elements, but it does cause the surface of bones to be altered, decreasing the likelihood of identifying cut marks, carnivore damage, or other surface treatments during analysis. Finally, as previously described, carnivore activities can directly lead to density mediated attrition as well as alter the faunal assemblage in other ways that can lead to a skewed or biased assemblage.

These results support my expectation that density mediated attrition was present in the assemblage and likely caused by a variety of natural (i.e. weathering) and human derived (i.e. burning) factors.

6.1.2 Seasonality

Healy Lake Village site was initially classified as a summer fishing camp that was occupied from mid-May till the first signs of winter, which usually occurred in October or November (McKennan 1959). The lake shore transformed into a year round village after 1910 due to the establishment of a nearby trading post (Cook 1989). Unfortunately, the Upper Cultural assemblage represents a palimpsest of the pre- and post- 1910 archaeological materials that could not be parsed apart. In addition, the sediments were not screened, causing the collection to be biased towards the larger mammals. Smaller mammals, birds and fish are the type of species frequently used for addressing seasonality, and unfortunately these will be under-represented due to the lack of screening. Are there other seasonal indicators present in the faunal record, and if so, what seasons are indicated?

This question was assessed using two different lines of evidence. The first was by simply looking at the species present in the Upper Cultural faunal assemblage in comparison to ethnographic frames of reference for the seasons in which species were taken. Caribou and moose proved to be the most abundant species in the collection. Ethnographically, caribou were hunted in the spring and fall, and moose were exploited in the summer, fall and winter. From solely looking at these two species, Healy Lake could have been occupied throughout all four seasons.

The other species identified in this collection also indicate that the Healy Lake Village site was inhabited year round. The spring season is indicated by the presence of muskrats and ptarmigans. Summer hunting is shown by the presence of ground squirrel, fish, and migratory bird remains. The fall season is revealed by sheep and fish bones. Finally, the winter months are indicated by the presence of ptarmigan remains.

The second way to assess seasonality at Healy Lake Village site is to look at age profiles for the caribou remains. Caribou give birth to one calf in late-May, and their long bones and vertebrae fuse at specific ages (Caribou Species Profile, Alaska Department of Fish and Game n.d.). As outlined in Chapter 5, the unfused caribou elements indicate varying ages ranging from 2 months to >45 months old. Therefore, the two specimens identified as 2-6 months old securely indicate a summer/fall hunting season. The age-spans represented by the remaining specimens cannot be assigned precisely to a season; while many of these could also reflect summer/fall hunting, some may be consistent with hunting in winter or spring, as well.

Based on the species identified at Healy Lake Village site and age profiles from the juvenile caribou remains, Healy Lake was occupied during all four seasons, which aligns with the fact that after A.D. 1910 the lake became a year round village. Unfortunately, the faunal material from the time that the site served as a summer fishing camp and the bones deriving from the year round village cannot be separated from one another, so I am unable discuss any differences in subsistence between these two occupation phases.

6.1.3 Faunal Procurement and Processing

By understanding how the inhabitants at Healy Lake used their animal resources, one can address questions relating to food procurement and processing. Ethnographically, the Upper Tanana people chose big game animals and fish as their primary subsistence targets (McKennan 1959; 1969; Vitt 1971). Smaller mammals and birds were hunted and caught, but did not make up a large part of the subsistence diet. That being said, the exploitation of those smaller species could indicate different subsistence patterns than recorded during the prehistoric period, caused by a widening of diet breadth or an increased reliance on fur-bearing animals in order to be a part of the cash economy.

The Upper Cultural faunal assemblage is largely composed of moose and caribou remains, which is consistent with regional models and the ethnographic record (Haynes and Simeone 2007; McKennan 1959; Shinkwin et al. 1980; Vitt 1971; Yesner 1989). However, the

amount of moose bones present at the site is higher than in previous time periods. Many late prehistoric and protohistoric faunal collections consist predominately of caribou remains (<90% of the collections) and only small amounts of other species (Yesner 1989). At Healy Lake, caribou remains make up 28.5% and moose represent 24.1% of the collection (based on NISP). This change could represent a widening of diet breadth caused by difference in mobility, a possible caribou population crash, or a change in value rank for each species with the formation of permanent camps.

In addition, the fur-bearing animals make up 3.7% of the total NISP and 39.9% of the total MNI count, which varies drastically from prehistoric assemblages that generally only have one or two specimens from these species (Potter 2008). Even with the lack of screening that might under- or inaccurately represent the smaller species, there are more bird, fish, and small mammal remains excavated from the Village site than found at other sites, even those slightly later in date like Paxson Lake Knoll and Point sites, Rat Indian Creek site, and Dakah De'nin Village (Yesner 1989). This supports the expectation that the relative prey rank of animals changed due to an increase in fur trading and the cash economy. Previously, larger animals (moose and caribou) were assigned the highest rank based on their caloric return; however, there appears to be a shift away from this and an increased focus on ranking animals based on their cash and trade return. However, this discrepancy could solely represent the poor preservation and post-deposition destruction of the smaller species at the prehistoric sites versus the exceptional preservation and lack of post-depositional destruction at Healy Lake.

Another difference from regional procurement patterns is the lack of Dall sheep remains. Archaeologically, sheep are the third most common mammal species in prehistoric and protohistoric assemblages (following caribou and moose; Shinkwin et al. 1980); however, there are only three sheep specimens in the Upper Cultural assemblage. This is consistent with the ethnographic record in which sheep were of lesser importance (McKennan 1959; Vitt 1971). On the other hand, it is possible that Healy Lake residents were taking sheep but discarding the bones elsewhere, leaving no faunal evidence.

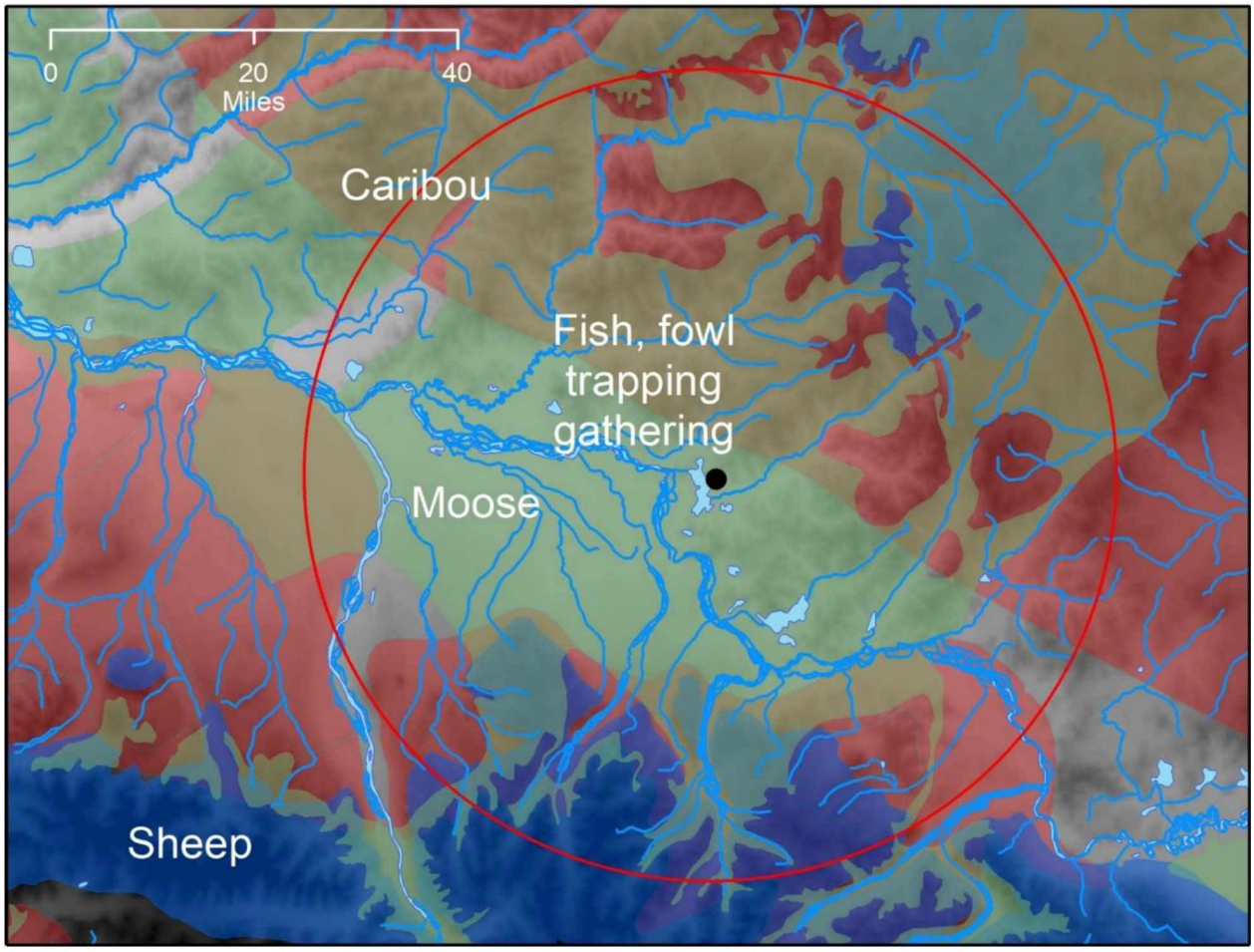

Figure 6-1. Subsistence hunting radii around Healy Lake Village site (Blue represents Dall sheep territory, red represents caribou, and green shows moose territory).

Even through the subsistence patterns changed between the prehistoric/protohistoric periods and the historic one, settlement location preferences do not seem to have altered. Healy Lake Village site is located on two bodies of water, the lake itself and the Healy River, where fishing, fowling, trapping of small game, and gathering could occur in close proximity to the settlement (Figure 6-1). Today, moose can also be obtained at the lake, in addition to a 10 mile radius around the lake (Moose Species Profile, Alaska Department of Fish and Game n.d.; Chester 2016). Depending on the season, caribou can be obtained within a 40 mile radius of the village site (Caribou Species Profile, Alaska Department of Fish and Game n.d.; Chester 2016). Sheep, though not as important during the historic period, are also present within 40 miles of the village site, in both the Alaska Range to the southwest and the Yukon Tanana Uplands to the northeast (Dall Sheep Species Profile, Alaska Department of Fish and Game n.d.; Chester 2016).

All five major resources (caribou, moose, sheep, fish and fowl) are obtainable within 40 mile radius of the Healy Lake Village site, as modeled by Shinkwin et al. (1980). This supports the idea that the location of this year round settlement is in fact driven by natural resource availability and not by the presence of a trading post at the mouth of the Healy River.

The next line of evidence that can shed light on food processing is the presence and placement of cut marks on particular bones. Dismemberment leaves cut marks on the articular surfaces for all skeletal elements (Binford 1981a). These were identified on the proximal and distal articular surfaces of femora, humeri, radial-ulnas, and tibiae for both caribou and moose remains. Filleting is another activity that produces cut marks on almost every skeletal part but the marks are focused on or around the fusion scars, i.e. the area between the articular surfaces and shafts (Binford 1981a). The only three elements on which cut marks could not indicate filleting are the skull, the cervical vertebrae, and carpals (Binford 1981a). Cut marks from skinning are present on the skull, mandible, metatarsals and metacarpals, whereas marks from marrow consumption preparation leaves scratches on long bone shaft fragments. By Binford's description and the placement of cut marks, all four types of processing are identified on the moose and caribou remains from the Upper Cultural assemblage at Healy Lake. Since all forms of carcass processing are present in the assemblage on majority of the skeletal elements for moose and caribou, it is possible that complete carcasses were brought back to the village for processing, instead of processing the animals at the hunting locations. In addition, the distribution of more long bone shafts in the southern area and ends in the north could suggest that marrow processing may have been processed in separate areas, but since there was no correlation to the grease index, it could also reflect different discard practices or density mediated attrition.

6.1.4 Spatial Distribution

During the excavation in the 1960 - 1970s, the focus was on the prehistoric record. For this reason, the excavation team did not thoroughly document the distribution of bones, historic material, or other items found on the ground surface or in the sod layer. A few different spatial analyses were conducted in order to gain an overall idea of how faunal processing and discard could have been laid out and organized across the Village site.

In general, there are more identifiable specimens in the southern excavation area than the northern area (almost three times the NISP counts); however, there were also more than twice as many units excavated in the southern area. In all of the distribution maps, three blocks

consistently showed a concentration of faunal remains: blocks N20E15, N20E20, and N25E20. This area stood out as a 'hot spot' in terms of the number of identifiable remains, carnivore damage, and cut marks, in addition to low values of burned materials. These patterns potentially indicate that this area represents a discard pile or midden. Conversely, these blocks yielded a low number of bird remains, which could suggest that there were different discard practices for mammal versus bird bones. As for fish, 59 of the 62 specimens originated from one block (N15E30), but I believe this represents excavation biases.

As mentioned in Chapter 3, only the identifiable bones were used in the majority of the spatial analyses (burned bone being the exception), since identifiable bones can provide more information in regards to size class, species, and element distributions. Both excavation areas are dominated by large and very large species, which is not surprising due to the fact that moose and caribou make up the majority of the faunal collection. What is interesting is the differential distribution of these species between the two excavation areas. As mentioned in Chapter 5, there are differences in the distribution patterns for each size class. The fish, and very small, small, medium, and very large mammal size class remains are more common in the southern excavation area, whereas the birds and the large mammal size class are more abundant in the northern area. This is even more evident when looking at the distribution of particular species between the two areas. The northern area contains far fewer species than the southern excavation area which could be due to the smaller sample size, yet there are a few species that are only identified in the northern area. The species that are only present in the northern area are black bear, horse, common goldeneye, and Harlequin duck. The northern excavation area also has a higher percentage of caribou (NISP = 399, 55.88% in the north and NISP = 360, 18.24% in the south) and mallard remains (NISP = 10, 1.40% in the north and NISP = 1, 0.05% in the south).

Before discussing what this spatial distribution could reflect, it is important to assess how extensive the supposed dog yard was through a consideration of the presence and distribution of carnivore damage. As discussed, there is not a statistical significant difference in the frequency of carnivore damage in the northern and southern excavation areas, meaning that the 'dog yard' was not centered to one area of the excavation. Furthermore, there were only 92 bones out of the 4087 specimens analyzed with carnivore damage (2.2%), which suggests that dogs did not significantly alter the collection.

The spatial patterns could reflect different processing areas at the site. As stated in the results chapter, the distribution of burning supports the identification of hearth features in the field notes while also identifying other areas that could reflect combustion features. In addition, the utility indices provide evidence that distinct processing areas between the north and south excavation area are a possibility. The caribou remains for both areas yielded positive correlations to the marrow index, and the moose remains were negatively correlated with the meat drying index and positively correlated to the marrow index only in the southern area. From this analysis, it can be suggested that caribou marrow processing occurred throughout the entire site, whereas moose marrow processing might have only occurred in the southern excavation area. The negative correlation to meat drying for moose in the southern area could reflect a few different things. First, it could indicate that meat drying was occurring in the southern area of the site but the products were taken off site as food for hunting trips, traded, or potentially even sold to miners as part of the developing cash economy. The second option is that this pattern reflects transportation decisions, meaning the elements generally dried were not brought back. Unfortunately, a definite conclusion cannot be drawn since density mediated attrition is present in the south but not the north, and that the elements which rank highly for meat drying are also low density bones, i.e., ribs and vertebrae. This is also the case for the positive correlation to the marrow index and the frequency of moose remains in the southern area, since the elements with the most marrow are also high density bones.

6.1.5 Euroamerican Interaction

Euroamerican goods were identified in abundance at Healy Lake Village site. These items include beads, cartridge casings, iron arrowheads, china, glass, harmonicas, thimbles, nails, wire, buttons, and a wide variety of metal products (See Appendix A; Cook 1989). But can evidence of trading be seen in the faunal assemblage? Did the inhabitants trade hunted meat with the Euromerican communities for other goods, as documented in the ethnographic record (Haynes and Simeone 2007)? If so, to what degree were they trading with the settler population? Once again, the lack of screening causes some problems when attempting to address these questions.

It is known that trading occurred between the Native community and the Euroamericans, but to what extent is uncertain. As stated in Chapter 2, animal furs were a major trade commodity and eight of the eighteen species identified (3.7% of the total NISP and 39.9% of the

total MNI count) in the Upper Cultural faunal assemblage are fur bearing species. It is unknown if the fur from these species was traded for the Euroamerican goods identified at the site, but due to the increased importance of these species compared to past periods, it can be suggested that they were in fact hunting fur-bearing animals with the intention of selling them to Euroamerican traders. The fur bearing animals that were identified in this collection include beaver, hare, fox, lynx, marten, mink, wolf, and squirrel. In addition to the identification of fur bearing species, four of these species yielded cut marks. This included a single wolf mandible, a red fox femur, and the patella and tibia of a lynx. Beaver yielded the most cut marks of the fur bearing species; eight elements had cut marks (mandible, rib, scapula, humerus, radius, femur, tibia, and phalanx). As outlined by Binford, the action of skinning can produce marks on the lower leg bones, front leg bones and the head. Most of the previously described placements of cut marks line up with Binford's description of skinning cut mark placements.

Ethnographically, Native communities were observed providing meat products to white miners (Haynes and Simeone 2007) demonstrating that they were part of the world-systems and cash economy. It has been suggested that the elements with the highest meat utility would have been traded away to the Euromericans (Crabtree 1990). If that was the case, the data should show a negative correlation to the meat utility index, indicating that the high ranked meat sections were absent from the site. While the data did show a negative relationship, it was not statistically significant, so not sure this alone serves as sufficient evidence that the residents were trading to the core as defined in WST.

Non-zooarchaeologically, there is evidence that people at Healy Lake were purchasing canned meat products; however, there is not currently any faunal evidence in support of the argument that they were trading for non-local meat, such as pigs and cattle. A single tooth from a horse was identified, whereas all other species identified in the Upper Cultural collection are Native Alaskan game. This does not mean that they were not buying or trading for domesticated meat, but rather that there were no faunal remains from domesticated animals. If meat was purchased off the bone, then this would result in no faunal remains from domestic species.

As pointed out in Chapter 2, in the beginning of the occupation during the historic period, the village would have been a part of the autonomous zone. The residents if Healy Lake Village site were receiving external trade items but did not have direct contact with the world-system. Unfortunately the slow progression from a member of the autonomous zone to part of the

dependent periphery is not visible due to the palimpsest nature of the Upper Cultural layer. All we can say is that in the beginning of occupation (A.D. 1880), the ethnographic record depicts Healy Lake Village as having no direct contact with the Euroamerican (autonomous zone). Around A.D. 1910 they would have progressed into the marginal periphery due to the increased sedentism and direct contact with the trading post nearby, and by the end of the occupation period (A.D. 1946) they were fully connected with the world-system.

There are two avenues for future work that could shed more light on this topic. Performing DNA tests or ZooMS on the unidentifiable remains or highly fragmented specimens, could expand the number of identifiable species. This could lead to the identification of non-local game such as cows or pigs that were purchased or traded for by individuals from Healy Lake. The second option is to examine written records from nearby trading posts, fur traders, or other documents that shows purchase records. This could clarify what Euroamerican goods were purchased or traded for other items by the neighboring Native communities. Through this process, it could be seen if the Healy Lake inhabitants were buying or trading for nonlocal meat products, and/or were trading furs for Euroamerican products.

6.2 Conclusions

This project provides valuable information regarding Athabascan subsistence practices during a dynamic time period in Interior Alaskan history. This information has been lacking due to an emphasis on the study of bone tools at Native village sites and a focus on Euroamerican subsistence practices. The goal of this thesis was to address three primary objectives, providing key comparative data and new insights on human decision making during the historic period in Interior Alaska.

The first was to identify, quantify, and spatially analyze the faunal remains. This was accomplished through the identification of 28 different bird, fish, and mammal species. Moose and caribou made up the majority of the collection, followed by beaver and lynx. Of the 18 mammal species identified to taxa, eight are classified as fur bearing species. The species data also revealed an uneven distribution of faunal remains between the north and south excavation areas. Caribou remains are more abundant in the northern excavation area, as are mallard, common goldeneye, harlequin duck, black bear, and horse. On top of an uneven distribution of species throughout the site, there are different patterns in the skeletal element data, which could

be the outcome of density mediated attrition, which impacted the southern excavation units and not the northern blocks.

The second research objective was to explain patterns in the zooarchaeological data in terms of taphonomy, human procurement and processing decisions. The site was affected by density mediated attrition in the southern blocks and not the northern ones, which can bias interpretations about human procurement and processing. Taphonomic analyses revealed that the site was altered by varying degrees of weathering, root etching, and carnivore damage, all of which can play a role in causing density mediated attrition. By looking at species abundance, spatial data, cut marks and correlations to utility indices, a few conclusions can be suggested in reference to procurement and processing decisions. The animals that were procured and brought back to the village were hunted, caught, or trapped year round. There also appears to be a shift in resource importance towards fur-bearing animals and away from sheep during the historic period. The species identified and age at death profile for the caribou remains suggest hunting could have occurred during all seasons. The cut mark analysis indicated that all four forms of processing as defined by Binford (i.e. skinning, dismemberment, filleting, and marrow consumption; 1981) took place at the site. As for processing decisions, the utility indices suggest that caribou marrow extraction occurred in both the northern and southern excavation areas, and moose meat drying and marrow extraction potentially took place in the southern area.

Finally, the last objective was to situate the Healy Lake Village site within regional models of historic land use and trade patterns. Subsistence hunting still appears to be the driving influence for the Native community, even with the increasing impact of the world-systems and cash economy. The location for the year round village appears to have been driven by local resource availability, which is consistent with other historic settlements in the Tanana Valley region. Besides the historical artifacts (i.e. spam cans, beads, nails, glass, etc.) that were identified during excavation, the only direct faunal evidence indicating trade between the Native community and the Euroamericans was the presence of a single horse tooth. All other species identified are local game that were ethnographically known to be food sources for Upper Tanana Athabascans bands.

Further work can and should be conducted on the Healy Lake Village site collection in addition to other Native Alaskan villages that date to the historic time period to gain a more

comprehensive understanding of Native subsistence practices and land use strategies during a vibrant era in Alaskan history.

References Cited

Ager, Thomas A.
1972 Surficial Geology and Quaternary History of the Healy Lake Area, Alaska. Master of Science, University of Alaska Fairbanks.

Anderson, J. H.
1975 A Palynological Study of Late Holocene Vegetation and Climate in the Healy Lake Area of Alaska. Arctic 28(1). Arctic Institute of North America: 62–69.

Andrews, Elizabeth F.
1975 Salcha: An Athapaskan Band of the Tanana River and Its Culture. M.A., University of Alaska Fairbanks.
1980 Progress Report of Tanacross Pilot Program to Record Information On Cemetery and Historic Sites-Healy Lake Area.

Behrensmeyer, Anna K.
1978 Taphonomic and Ecologic Information from Bone Weathering. Paleobiology 4(2). Paleontological Society: 150–162.

Berna, Francesco
2017 FTIR Microscopy. *In* Archaeological Soil and Sediment Micromorphology. Cristiano Nicosia and Georges Stoops, eds. Pp. 411–415. Wiley Blackwell.

Binford, L. R.
1967 Smudge Pits and Hide Smoking: The Use of Analogy in Archaeological Reasoning. American Antiquity 32(1): 1-12.
1978 Nunamiut Ethnoarchaeology. Academic Press.
1981a Bones: Ancient Men and Modern Myths. Academic Press, Inc.
1981b Behavioral Archaeology and the "Pompeii Premise." Journal of Anthropological Research: 195–208.

Bird, Douglas W., and James F. O'Connell
2006 Behavioral Ecology and Archaeology. Journal of Archaeological Research 14(2). Springer US: 143–188.

Blumenschine, Robert J.
1988 An Experimental Model of the Timing of Hominid and Carnivore Influence on Archaeological Bone Assemblages. Journal of Archaeological Science 15(5): 483–502.

Borgerhoff Mulder, Monique, and Ryan Schacht
2012 Human Behavioural Ecology. Elsevier Oceanography Series.

Bunn, Henry T.
1986 Patterns of Skeletal Representation and Hominid Subsistence Activities at Olduvai Gorge, Tanzania, and Koobi Fora, Kenya. Journal of Human Evolution 15(8): 673–690.

Bunn, Henry T., and Ellen M. Kroll
1986 Systematic Butchery by Plio/Pleistocene Hominids at Olduvai Gorge, Tanzania. Current Anthropology 27(5): 431–452.

Byers, David A., and Andrew Ugan
2005 Should We Expect Large Game Specialization in the Late Pleistocene? An Optimal Foraging Perspective on Early Paleoindian Prey Choice. Journal of Archaeological Science 32(11): 1624–1640.

Capps, S.R.
1914. Mineral Resources of the Chaisana-White River District. *In* Mineral Resources of Alaska: Report on Progress on Investigations in 1914. U.S. Geological Survey Bulletin 622: 189-228.

Caribou Species Profile
N.d. Alaska Department of Fish and Game
https://www.adfg.alaska.gov/index.cfm?adfg=caribou.main, accessed March 4, 2019.

Charnov, E. L.
1976 Optimal Foraging, the Marginal Value Theorem. Theoretical Population Biology 9(2): 129–136.

Chester, Sharon
2016 The Arctic Guide Widelife of the Far North. Princeton University Press.

Clark, Jamie L.
2017 The Howieson's Poort Fauna from Sibudu Cave: Documenting Continuity and Change within Middle Stone Age Industries. Journal of Human Evolution 107: 49–70.

Clark, Jamie L., and Bertrand Ligouis
2010 Burned Bone in the Howieson's Poort and Post-Howieson's Poort Middle Stone Age Deposits at Sibudu (South Africa): Behavioral and Taphonomic Implications. Journal of Archaeological Science 37(10): 2650–2661.

Cook, John P.
1969 Early Prehistory of Healy Lake, Alaska. University of Wisconsin, Madison.
1989 Historic Archaeology and Ethnohistory at Healy Lake, Alaska. Arctic 42(2). Arctic Institute of North America: 109–118.
1996 Healy Lake. *In* American Beginnings: The Prehistory and Palaeoecology of Beringia. Frederick Hadleigh West, ed. Pp. 323–327. The University of Chicago Press.

Crabtree, Pam J.
1990 Zooarchaeology and Complex Societies: Some Uses of Faunal Analysis for the Study of Trade, Social Status, and Ethnicity. Archaeological Method and Theory 2: 155–205.

Crowell, Aron L.
1997 Archaeology and the Capitalist World System: A Study from Russian America. Plenum Press, New York.

Dall Sheep Species Profile
N.d. Alaska Department of Fish and Game
http://www.adfg.alaska.gov/index.cfm%3Fadfg%3Ddallsheep.main, accessed March 4, 2019.

deFrance, Susan D.
2009 Zooarchaeology in Complex Societies: Political Economy, Status, and Ideology. Journal of Archaeological Research 17(2). Springer US: 105–168.

Dixon, James E.
2013 Late Pleistocene Colonization of North America from Northeast Asia: New Insights from Large-Scale Paleogeographic Reconstructions. Quaternary International: The Journal of the International Union for Quaternary Research 285: 57–67.

Ekholm, Kasja, and Jonathan Friedman
1985 Towards a Global Anthropology. Critique of Anthropology 5(1). SAGE Publications Ltd: 97–119.

Fernandez-Jalvo, Yolanda, and Peter Andrews
2016 Atlas of Taphonomic Identifications: 1001+ Images of Fossil and Recent Mammal Bone Modification. Vertebrate Paleobiology and Paleoanthropology. Springer Netherlands.

Field, Andy
2009 Discovering Statistics Using IBM SPSS Statistics. 3rd edition. SAGE Publications Ltd.

Friesen, Trevor Max
2001 A Zooarchaeological Signature for Meat Storage: Re-Thinking the Drying Utility Index. American Antiquity 66(2): 315–331.
2013 When Worlds Collide: Hunter-Gatherer World-System Change in the 19th Century Canadian Arctic. University of Arizona Press.

Gardner, James S.
1984 General Environment. *In* Handbook of North American Indians: Subarctic. June Helm, ed. Pp. 5–14. Smithsonian Institutinon.

Garvey, Raven, and Robert L. Bettinger
2014 Adaptive and Ecological Approaches to the Study of Hunter-Gatherers. *In* The Oxford Handbook of the Archaeology and Anthropology of Hunter-Gatherers. Vicki Cummings, Peter Jordan, and Marek Zvelebil, eds. Pp. 69–91. Oxford University Press.

Gould, Richard A., and Patty Jo Watson
1982 A Dialogue on the Meaning and Use of Analogy in Ethnoarchaeological Reasoning. Journal of Anthropological Archaeology 1(4). Academic Press: 355–381.

Grayson, D. K., and C. J. Frey
2004 Measuring Skeletal Part Representation in Archaeological Faunas. Journal of Taphonomy 2(1): 27-42.

Haggar, Jenny E.
2008 A Comparison of Subsistence Patterns at Two Eastern Alaska WAMCATS Stations. Donald L. Hardesty, ed. University of Nevada, Reno.

Hall, Thomas D., and Christopher Chase-Dunn
1993 The World-Systems Perspective and Archaeology: Forward into the Past. Journal of Archaeological Research 1(2): 121–143.

Haynes, Terry L., and William E. Simeone
2007 Upper Tanana Ethnographic Overview and Assessment, Wrangell St. Elias National Park and Preserve. 325. Alaska Department of Fish and Game.

Heiman, Gary
2000 Basic Statistics for the Behavioral Sciences. Houghton Mifflin Company.

Hesse, B., and P. Wapnish
1985 Animal Bone Archaeology: From Objectives to Analysis. Manuals on Archeology 5. Taraxacum, Washington, DC.

Hosley, Edward H.
1981 Environment and Culture in the Alaska Plateau. *In* Handbook of North American Indians: Subarctic. June Helm, ed. Pp. 533–545. Smithsonian Institution.

Ingstad, Helge
1954 Nunamiut: Among Alaska's Inland Eskimos. G. Allen and Unwin Ltd.

Kelly, Dr Robert L.
2013 The Lifeways of Hunter-Gatherers: The Foraging Spectrum. 2nd Revised ed. edition. Cambridge University Press.

Klein, Richard G., and Kathryn Cruz-Uribe
1984 The Analysis of Animal Bones from Archeological Sites. University of Chicago Press.

Kohl, Philip L.
1987 The Use and Abuse of World Systems Theory: The Case of the Pristine West Asian State. *In* Advances in Archaeological Method and Theory. Michael B. Schiffer, ed. Pp. 1–35. San Diego: Academic Press.

Kristiansen, Kristian
1987 Centre and Periphery in Bronze Age Scandinavia. *In* Centre and Periphery in the Ancient World. M. Rowlands, M. Larsen, and K. Kristiansen, eds. Pp. 75–85. Cambridge University Press.

Lam, Y. M., Xingbin Chen, and O. M. Pearson
1999 Intertaxonomic Variability in Patterns of Bone Density and the Differential Representation of Bovid, Cervid, and Equid Elements in the Archaeological Record. American Antiquity 64(2). Society for American Archaeology: 343–362.

Le Blanc, Raymond Joseph
1984 The Rat Indian Creek Site and the Late Prehistoric Period in the Interior Northern Yukon. Paper No. 11. Museum of Man Mercury Series, Archaeological Survey of Canada.

Lupo, Karen D.
2007 Evolutionary Foraging Models in Zooarchaeological Analysis: Recent Applications and Future Challenges. Journal of Archaeological Research 15(2): 143–189.

Lyman, R. Lee
1994a Vertebrate Taphonomy. Cambridge Manuals in Archaeology. Cambridge University Press.
1994b Quantitative Units and Terminology in Zooarchaeology. American Antiquity 59(1). Society for American Archaeology: 36–71.
2004 The Concept of Equifinality in Taphonomy. Journal of Taphonomy 2(1): 15-26.
2008 Quantitative Paleozoology. Cambridge Manuals in Archaeology. Cambridge University Press.

MacArthur, Robert H., and Eric R. Pianka
1966 On Optimal Use of a Patchy Environment. The American Naturalist 100(916). University of Chicago Press: 603–609.

Madrigal, Lorena
1998 Statistics for Anthropology. 2nd edition. Cambridge University Press.

Marean, Curtis W.
1991 Measuring the Post-Depositional Destruction of Bone in Archaeological Assemblages. Journal of Archaeological Science 18(6): 677–694.

Marean, Curtis W., and Leanne Bertino
1994 Intrasite Spatial Analysis of Bone: Subtracting the Effect of Secondary Carnivore Consumers. American Antiquity 59(4): 748–768.

Marean, Curtis W., and Lillian M. Spencer
1991 Impact of Carnivore Ravaging on Zooarchaeological Measures of Element Abundance. American Antiquity 56(4). Society for American Archaeology: 645–658.

Marean, Curtis W., Lillian M. Spencer, Robert J. Blumenschine, and Salvatore D. Capaldo
1992 Captive Hyaena Bone Choice and Destruction, the Schlepp Effect and Olduvai Archaeofaunas. Journal of Archaeological Science 19(1): 101–121.

Marshall, Fiona, and Tom Pilgram
1993 NISP vs. MNI in Quantification of Body-Part Representation. American Antiquity 58(2). Society for American Archaeology: 261–269.

McKennan, Robert A.
1959 The Upper Tanana Indians. Irving Rouse, ed. Yale University Publications.

1969 Athapaskan Groups of Central Alaska at the Time of White Contact. Ethnohistory 16(4). Duke University Press: 335–343.

1981 Tanana. *In* Handbook of North American Indians: Subarctic. June Helm, ed. Pp. 562–576. Smithsonian Institution.

Messerschmidt, Robert G., and Matthew A. Harthcock, eds.
1988 Infrared Microspectroscopy: Theory and Applications. M. Dekker, New York.

Metcalfe, Duncan, and Kevin T. Jones
1988 A Reconsideration of Animal Body-Part Utility Indices. American Antiquity 53(3): 486–504.

Moose Species Profile
N.d. Alaska Department of Fish and Game
https://www.adfg.alaska.gov/index.cfm?adfg=moose.main, accessed March 4, 2019.

Morin, Eugène
2007 Fat Composition and Nunamiut Decision-Making: A New Look at the Marrow and Bone Grease Indices. Journal of Archaeological Science 34(1): 69–82.

Morin, Eugène, and Elspeth Ready
2013 Foraging Goals and Transport Decisions in Western Europe during the Paleolithic and Early Holocene. *In*Zooarchaeology and Modern Human Origins. Jamie L. Clark and John D. Speth, eds. Pp. 227–269. Vertebrate Paleobiology and Paleoanthropology. Springer Netherlands.

Morlan, Richard E.
1994 Bison Bone Fragmentation and Survivorship: A Comparative Method. Journal of Archaeological Science 21(6): 797–807.

Orme, Bryony
1974 Twentieth-Century Prehistorians and the Idea of Ethnographic Parallels. Man 9(2): 199–212.

Pedersen, Mikkel W., Anthony Ruter, Charles Schweger, et al.
2016 Postglacial Viability and Colonization in North America's Ice-Free Corridor. Nature 537(7618): 45–49.

Peregrine, Peter N.
1996 Archaeology and World-Systems Theory. Sociological Inquiry 66(4): 486–495.

Pokines, James T.
2000 Microfaunal Research Design in the Cantabrian Spanish Paleolithic. Journal of Anthropological Research 56(1): 95–112.

Potter, Ben A.
2008 Exploratory Models of Intersite Variability in Mid to Late Holocene Central Alaska. Arctic 61(4): 407–425.

Potter, Ben A., Joshua D. Reuther, Vance T. Holliday, et al.
2017 Early Colonization of Beringia and Northern North America: Chronology, Routes, and Adaptive Strategies. Quaternary International 444: 36–55.

Preacher, K. J.
2001 Calculation for the chi-square test: An interactive calculation tool for chi-square tests of goodness of fit and independence [Computer software]. Available from http://quantpsy.org.

Reitz, Elizabeth J., and Elizabeth S. Wing
2008 Zooarchaeology (Cambridge Manuals in Archaeology). 2 edition. Cambridge University Press.

Shinkwin, Anne D.
1979 Dakah De'nin's Village and the Dixthada Site: A Contribution to Northern Athapaskan Prehistory. 91. Ottawa: National Museum of Man Mercury Series, Archaeological Survey of Canada.

Shinkwin, Anne, Jean Aigner, and Elizabeth Andrews
1980 Land Use Patterns in the Upper Tanana Valley, Alaska. Anthropological Papers of the University of Alaska 19(2): 43–53.

Shinkwin, Anne D., and M. Case
1984 Modern Foragers: Wild Resource Use in Nenana Village, Alaska. 91. Alaskan Department of Fish and Game.

Simeone, William E.
1982 A History of Alaskan Athapaskans: A History of Alaskan Athapaskans Including Description of Athapaskan Culture and a Historic Narrative, 1785-1971. Alaska Historic Commission.

1998 The Northern Athabaskan Potlatch in East-Central Alaska, 1900-1930. Arctic Anthropology 35(2). University of Wisconsin Press: 113–125.

Smith, Brian C.
2011 Fundamentals of Fourier Transform Infrared Spectroscopy, Second Edition. CRC Press.

Smith, Eric Alden
1992 Human Behavioral Ecology: I. Evolutionary Anthropology 1(1). John Wiley & Sons, Inc.: 20–25.

Squires, Kirsty E., Tim J. U. Thompson, Meez Islam, and Andrew Chamberlain
2011 The Application of Histomorphometry and Fourier Transform Infrared Spectroscopy to the Analysis of Early Anglo-Saxon Burned Bone. Journal of Archaeological Science 38(9): 2399–2409.

Stiner, Mary C.
1994 Honor Among Thieves: A Zooarchaeological Study of Neandertal Ecology. Princeton NJ: Princeton.

Stiner, Mary C., Steven L. Kuhn, Stephen Weiner, and Ofer Bar-Yosef
1995 Differential Burning, Recrystallization, and Fragmentation of Archaeological Bone. Journal of Archaeological Science 22(2): 223–237.

Strong, B. Stephen
1976 Historical Sequence of the Patterns of Production of the Ahtna Athabascan Indians of the Upper Copper Valley, Alaska: The Development of Capitalism in Alaska. Ph.D., McGill University, Montreal Quebec.

Subías, Sandra Montón
2002 Cooking in Zooarchaeology: Is This Issue Still Raw. Consuming Passions and Patterns of Consumption, McDonald Institute for Archaeological Research, Cambridge. academia.edu: 7–15.

Takken Beijersbergen, L. M., and A. K. Hufthammer
2012 Age Determination of Reindeer (Rangifer Tarandus) Based on Postcranial Elements. A Bouquet of Archaeozoological Studies 21. Barkhuis Groningen: 11–20.

Thomas, David H.
1969 Great Basin Hunting Patterns: A Quantitative Method for Treating Faunal Remains. American Antiquity 34(4): 392–401.

Thompson, T. J. U.
2004 Recent Advances in the Study of Burned Bone and Their Implications for Forensic Anthropology. Forensic Science International 146S: S203–S205.

Thompson, T. J. U., Marie Gauthier, and Meez Islam
2009 The Application of a New Method of Fourier Transform Infrared Spectroscopy to the Analysis of Burned Bone. Journal of Archaeological Science 36(3): 910–914.

Thompson, T. J. U., M. Islam, and M. Bonniere
2013 A New Statistical Approach for Determining the Crystallinity of Heat-Altered Bone Mineral from FTIR Spectra. Journal of Archaeological Science 40(1): 416–422.

Todd, Lawrence C.
1993 Body Parts, Butchery, and Postdepositional Processes at Round Spring: Formational Analysis of Body Size III (Brain) Bovids. *In* Hogan Pass: Final Report on Archaeological Investigations Along Forest Highway 10 (State Highway 72), Sevier County, Utah. Michael D. Metcalf, Kelly J. Pool, Kae MacDonald, and Anne McKibbin, ed. Pp. 341–386. Metcalf Archaeological Consultants, Eagle, Colorado.

Todd, Lawrence C., and D. J. Rapson
1988 Long Bone Fragmentation and Interpretation of Faunal Assemblages: Approaches to Comparative Analysis. Journal of Archaeological Science 15: 307–325.

Upham, S.
1992 Interaction and Isolation: The Empty Spaces in Panregional Political and Economic Systems. *In* Resources, Power, and Interregional Interaction. E. Schortman and P. Urban, eds. Pp. 139–152. New York: Plenum Press.

Vitt, Ramon B.
1971 Hunting Practices of the Upper Tanana Athapaskans. University of Alaska.

Waguespack, Nicole M.
2002 Caribou Sharing and Storage: Refitting the Palangana Site. Journal of Anthropological Archaeology 21: 396–417.

Wahrhaftig, Clyde
1965 Physiographic Divisions of Alaska. US Government Printing Office.

Wallerstein, Immanuel M.
2004 World-Systems Analysis: An Introduction. Duke University Press.

Wandsnider, Luann
1997 The Roasted and the Boiled: Food Composition and Heat Treatment with Special Emphasis on Pit-Hearth Cooking. Journal of Anthropological Archaeology 16(1): 1–48.

Whitney, James Warren
2009 Historical Archaeology of Marion Creek, Alaska: Placer Gold Mining and the Capitalist World-System. University of Alaska Fairbanks.

Winterhalder, Bruce, and Eric Alden Smith
2000 Analyzing Adaptive Strategies: Human Behavioral Ecology at Twenty-Five. Evolutionary Anthropology Issues News and Reviews 9(2): 51–72.

Wobst, H. Martin
1978 The Archaeo-Ethnology of Hunter-Gatherers or the Tyranny of the Ethnographic Record in Archaeology. American Antiquity 43(2): 303–309.

Yeshurun, R., N. Marom, and G. Bar-Oz
2007 Differencial Fragmentation of Different Ungulate Body-Size: A Comparison of Gazelle and Fallow Deer Bone Fragmentation in Levantine Prehistoric Assemblages. Journal of Taphonomy 5(3): 137-148.

Yesner, David Raymond
1980 Caribou Exploitation in Interior Alaska: Paleoecology at Paxson Lake Sites. *In* Anthropological Papers of the University of Alaska. Anne D. Shinkwin, G. Richard Scott, and William B. Workman, eds. Pp. 15–32. University of Alaska Press.
1989 Moose Hunters of the Boreal Forest? A Re-Examination of Subsistence Patterns in the Western Subarctic. Arctic 42(2). Arctic Institute of North America: 97–108.

Younie, Angela Marie
2015 Linda's Point and the Village Site: A New Look at the Chindadn Complex and Archaeological Record at Healy Lake, Alaska. Texas A&M University.

Appendices

Appendix A: List of Western Goods Found at Healy Lake, Adapted from Cook 1989.

Description	Description
Metal	Household
Containers/Cans	Clock/Watch Parts
Can Lids	Fork, Spoon
Can Tobacco	Fountain Pen
Metal Tube	Harmonica
Pill Box	Metal Comb
Clothing Parts	Safety Pin
Button, Metal	Scissors
Buckle	Stove Lid
Hunting/Fishing/Trapping Parts	Thimble
Gun Parts	Miscellaneous
Cartridge Cases	Battery Fragments
Bullets	Bottle Cap
Musket Ball	Brake Shoe
Net Sinker	Indian Head cent
Metal Arrowhead	Key
Trap Parts	Metal Bar
Wire/Chain	Sled Brace
Dog Chain	Spark Plug
Tools/Hardware	Wheel, Cogged
Doorknob	Glass
File	Bottles
Jackknife	China
Lock	Beads
Scraper, Metal	Buttons
Fasteners	
Bolt/Nut	
Nails	
Rivets	
Screws	
Spikes	

Appendix B: Element Portion Coding System (Modified from Stiner 2004)

GENERAL PORTION CODES:
1 complete
2 nearly complete
56 half (561 lateral dimension; 562 vertical)
80 short diaphysis (tube)
85 long diaphysis (for rib, proximal diaphysis with dorsal ridge
86 diaphysis with foramen
90 shaft fragment
95 spongy bone fragment
97 flat bone fragment
99 indeterminate fragment

HORN/ANTLER:
10 rosette (base)
11 pedicle-braincase
12 shaft-rosette-pedicle-braincase
13 tip/tine (2=shaft fragment; 80=diaphysis section)

CRANIUM & MANDIBLE:
19 hyoid
20 premaxilla (or "incisive" of anterior mandible)
21 nasal
22 zygomatic (mastoid-squamous zone)
23 maxilla (~complete half)
24 maxilla fragment (241 anterior rim; 242 posterior rim)
25 petrous
26 auditory bulla
27 braincase fragment
28 occipital (dorsal rim)
29 occipital condyle (right or left)
30 frontal foramen (or anterior foramen of mandible)
31 orbit lower rim (or gonial angle of mandible)
32 lacrimal (foramen)
Other: 16 post margin of mandibular symphysis; 17 basi-cranium; 18 upper orbit

MANDIBLE:
33 middle horizontal ramus
34 mid-anterior horizontal ramus
35 anterior horizontal ramus (anterior alvaeolus of LP2)
36 mid-posterior horizontal ramus
37 posterior horizontal ramus (dorsal ridge behind LM3)
38 concavity between condyle-coronoid (or base of glenoid process of scapula)
39 base of horizontal ramus
40 condyle
41 coronoid process
42 condyle & coronoid
43 ascending ramus (431lingual foramen)
44 horizontal ramus (whole)
45 middle horizontal ramus
46 anterior horizontal ramus
47 posterior horizontal ramus
48 mid-anterior horizontal ramus
49 mid-posterior horizontal ramus

VERTEBRAE:
50 epiphysis (501 anterior; 502 posterior)
51 centrum (body intact)
52 transverse process
53 pre-zygopophyses (53-53=intact pair)
54 post-zygopophyses (54-54=intact pair)
55 dorsal spine (also proximal "heel" of ulna olecranon)
56 half
57 anterior-ventral articulation
58 zygopophysis (type unknown)

INNOMINATE:
60 acetabulum fragment
61 acetabulum section—pubic body (611 anterior rim of symphysis; 612 ridge)
62 acetabulum, complete
63 acetabulum & ilium (~complete)
64 acetabulum section—iliac body fragment
65 acetabulum-ischium (~complete)
66 acetabulum section—ischial body fragment
67 iliac body (diaphysis)
68 iliac blade (681 dorsal tip; 682 ventral tip)
69 ilium
70 ischial body
71 ischial blade (711 base or coxae; 712 lateral tuberosity)
72 ischium

LIMB BONES & RIB (LARGER PORTIONS):
73 proximal (P) epiphysis complete
74 P epiphysis fragment (see also 87 - 90)
75 P < 1/2
76 P 1/2
77 P > 1/2
78 distal (D) > 1/2
79 D 1/2
80 D < 1/2
81 D epiphysis fragment (see also portions 83 - 86)
82 Distal epiphysis complete

LIMB BONE & RIB EPIPHYSIS PORTIONS:
83 medial distal (D) epiphysis
84 lateral D epiphysis
85 anterior D epiphysis
86 posterior D epiphysis
87 anterior proximal (P) epiphysis
88 posterior P epiphysis
89 medial P epiphysis
90 lateral P epiphysis (for calcaneum: 901 tuberosity, 902 tip)

LIMB BONE SHAFT & INNOMINATE FEATURES:
990 w/ foramen present
991 w/ proximal rim of attachment scar (radius or ulna)
992 waist (narrowest cross-section or collum) of diaphysis (scapula)
994 anterior "angle" (tibia or scapula)
995 muscle insertion or ligament scar
996 posterior rugosities (tibia or innominate)
997 interior diagonal lattice (humerus)
998 anterior groove (metapodials)
999 posterior groove (metapodials)

Appendix C: Skeletal Elements Recovered from Healy Lake Village Site for Each Taxa.

Bird Species:

Common Goldeneye Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Coracoid	1	1	0	0	0	1	0	0	1	0	1	0	0.5	33.33%
Humerus	3	1	2	0	0	1	2	0	3	0	2	0	1.5	100.00%
TOTAL	**4**	**2**	**2**	**0**	**0**	**2**	**2**							

Harlequin Duck Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Tibiotarsus	1	0	0	1	0	0	1	0	1	0	1	0	0.5	100.00%
TOTAL	**1**	**0**	**0**	**1**	**0**	**0**	**1**							

Common Merganser Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Furcula	1	1	0	0	0	0	0	1	1	0	1	0	0.5	100.00%
TOTAL	**1**	**1**	**0**	**0**	**0**	**0**	**0**							

Mallard Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Sternum	9	0	0	0	0	—	—	—	1	0	1	0	1	100.00%
Ulna	1	0	1	0	0	1	0	0	1	0	1	0	0.5	50.00%
Carpometacarpus	1	1	0	0	0	1	0	0	1	0	1	0	0.5	50.00%
TOTAL	**11**	**1**	**1**	**0**	**0**	**2**	**0**							

Lesser Scaup Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Carpometacarpus	1	0	0	0	0	1	0	0	1	0	1	0	0.5	100.00%
TOTAL	**1**	**0**	**0**	**0**	**0**	**1**	**0**							

Canada Goose Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Furcula	1	0	0	0	0	0	0	1	1	0	1	0	0.5	100.00%
Scapula	1	1	0	0	0	1	0	0	1	0	1	0	0.5	100.00%
Ulna	1	1	0	0	0	0	1	0	1	0	1	0	0.5	100.00%
Tibiotarsus	1	0	1	0	0	0	1	0	1	0	1	0	0.5	100.00%
Tarsometatarus	1	0	0	0	0	0	1	0	1	0	1	0	0.5	100.00%
TOTAL	**5**	**2**	**1**	**0**	**0**	**1**	**3**							

Swan Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Scapula	1	1	0	0	0	0	1	0	1	0	1	0	0.5	100.00%
Tarsometatarus	1	0	0	0	0	1	0	0	1	0	1	1	0.5	100.00%
TOTAL	**2**	**1**	**0**	**0**	**0**	**1**	**1**							

Mammal Species:

Snowshoe Hare Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Maxilla	1	0	0	0	0	0	0	1	1	0	1	0	0.5	25.00%
Mandible	6	1	0	0	0	5	1	0	4	0	4	0	2.0	100.00%
Lumbar Vertebrae	1	0	0	0	1	—	—	—	1	1	1	1	0.1	7.14%
Immoninate	2	0	0	0	0	0	1	1	2	0	2	0	1.0	50.00%
Femur	2	0	1	1	0	0	2	0	1	0	1	0	0.5	25.00%
Tibia	2	0	1	1	0	0	2	0	1	0	1	0	0.5	25.00%
TOTAL	**14**	**1**	**2**	**2**	**1**	**5**	**6**							

North American Porcupine Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Maxilla	1	0	0	0	0	0	1	0	1	0	1	0	0.5	100.00%
Mandible	1	0	0	0	0	0	0	1	1	0	1	0	0.5	100.00%
TOTAL	**2**	**0**	**0**	**0**	**0**	**0**	**1**							

c.f. North American Porcupine Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Radius	1	0	0	1	0	0	0	1	1	0	1	0	0.5	100.00%
TOTAL	**1**	**0**	**0**	**1**	**0**	**0**	**0**							

Beaver Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Cranium	3	0	0	0	0	—	—	—	3	0	3	0	3.0	66.7%
Mandible	10	1	0	0	0	4	6	0	9	0	6	0	4.5	100.0%
Atlas	1	1	0	0	0	—	—	—	1	0	1	0	1.0	22.2%
Ribs	2	0	0	1	0	—	—	—	2	0	1	0	0.1	1.6%
Scapula	1	0	0	0	0	1	0	0	1	0	1	0	0.5	11.1%
Humerus	4	1	3	0	1	3	1	0	4	1	3	1	2.0	44.4%
Radius	2	0	0	2	0	1	1	0	2	0	1	0	1.0	22.2%
Ulna	9	1	0	7	2	7	1	1	9	2	7	2	4.5	100.0%
Innominate	5	0	0	0	0	2	3	0	5	0	5	0	2.5	55.6%
Femur	7	0	0	1	2	6	1	0	6	2	6	2	3.0	66.7%
Tibia	3	1	2	0	0	1	2	0	3	0	2	0	1.5	33.3%
Calcaneus	2	1	0	0	0	1	1	0	2	0	1	0	1.0	22.2%
Metapodials	2	1	0	1	1	—	—	—	2	1	2	1	0.1	1.2%
Phalanges	1	1	0	0	0	—	—	—	1	0	1	0	0.0	0.4%
TOTAL	**52**	**8**	**5**	**12**	**6**	**26**	**16**							

c.f. Beaver Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Femur	1	0	0	0	0	0	1	0	1	0	1	0	0.5	100.00%
TOTAL	**1**	**0**	**0**	**0**	**0**	**0**	**1**							

Muskrat Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Mandible	5	1	0	0	0	1	4	0	4	0	4	0	2.0	100.00%
Femur	2	1	0	1	1	1	1	0	2	1	2	1	1.0	50.00%
Astragalus	1	1	0	0	0	0	0	1	1	0	1	1	0.5	25.00%
Phalanges	1	1	0	0	0	—	—	—	1	0	1	1	0.0	0.96%
TOTAL	**9**	**4**	**0**	**1**	**1**	**2**	**5**							

c.f. Arctic Ground Squirrel Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Humerus	1	0	0	0	0	1	0	0	1	0	1	0	0.5	1
Metatarsal	2	2	0	0	0	0	0	0	2	0	1	0	0.1	0.2
Calcaneus	1	1	0	0	0	1	0	0	1	0	1	0	0.5	1
Astragalus	1	1	0	0	0	0	0	0	1	0	1	0	0.5	1
Phalanges	1	1	0	0	0	—	—	—	1	0	1	0	0.1	0.2
TOTAL	**6**	**5**	**0**	**0**	**0**	**2**	**0**							

Northern Bog Lemming Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Crabium	1	0	0	0	0	—	—	—	1	0	1	0	1	100.00%
TOTAL	**1**	**0**	**0**	**0**	**0**	**0**	**0**							

Lynx Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Mandible	2	1	0	0	0	0	2	0	2	0	2	0	1	66.7%
Rib	1	0	0	0	0	—	—	—	1	0	1	0	0.4	26.7%
Carpals	4	4	0	0	0	4	0	0	4	0	1	0	0.3	20.0%
Femur	2	0	2	0	2	0	2	0	2	2	2	2	1	66.7%
Patella	1	1	0	0	0	1	0	0	1	0	1	0	0.5	33.3%
Tibia	3	1	1	1	3	3	0	0	2	2	2	2	1	66.7%
Fibula	3	0	1	2	3	0	3	0	2	2	2	2	1.5	100.0%
Metatarsal	3	0	0	3	0	3	0	0	3	0	1	0	0.4	26.7%
Calcaneus	1	1	0	0	1	1	0	0	1	1	1	1	0.5	33.3%
Astragalus	1	1	0	0	0	1	0	0	1	0	1	0	0.5	33.3%
Sesamoids	1	1	0	0	0	0	0	1	1	0	1	0	—	—
TOTAL	**22**	**10**	**4**	**6**	**9**	**13**	**7**							

c.f. Lynx Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Femur	1	0	1	0	1	1	0	0	1	1	1	1	0.5	100.00%
TOTAL	**1**	**0**	**1**	**0**	**1**	**1**	**0**							

Dog Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Mandible	1	0	0	0	0	1	0	0	1	0	1	0	0.5	100.00%
TOTAL	**1**	**0**	**0**	**0**	**0**	**1**	**0**							

c.f. Dog Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Lumbar Vertebrae	1	0	0	0	0	–	–	–	1	0	1	0	0.2	40.00%
Humerus	1	1	0	0	1	0	1	0	1	1	1	1	0.5	100.00%
TOTAL	**2**	**1**	**0**	**0**	**1**	**0**	**1**							

Red Fox Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Maxilla	1	0	0	0	0	0	1	0	1	0	1	0	0.5	50.00%
Caudal Vertebrae	1	1	0	0	0	–	–	–	1	0	1	0	–	–
Innominate	1	0	0	0	0	0	1	0	1	0	1	0	0.5	50.00%
Sacrum	1	0	0	1	0	–	–	–	1	0	1	0	1	100.00%
Femur	1	0	1	0	0	0	1	0	1	0	1	0	0.5	50.00%
TOTAL	**5**	**1**	**1**	**1**	**0**	**0**	**3**							

c.f. Red Fox Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Caudal Vertebrae	1	0	–	–	1	–	–	–	1	1	1	1	–	–
TOTAL	**1**	**0**	**–**	**–**	**1**	**–**	**–**							

Black Bear Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Metapodial	1	0	0	1	0	0	0	1	1	0	1	0	0.1	100.0%
TOTAL	**1**	**0**	**0**	**1**	**0**	**0**	**0**							

c.f. Brown Bear Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Ulna	1	0	0	1	1	1	0	0	1	1	1	1	0.5	100.00%
TOTAL	**1**	**0**	**0**	**1**	**1**	**1**	**0**							

American Mink Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Mandible	3	0	0	0	0	2	1	0	3	0	2	0	1.5	100.00%
TOTAL	**3**	**0**	**0**	**0**	**0**	**2**	**1**							

c.f. American Mink Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Metapodial	1	1	0	0	0	0	0	0	1	0	1	0	0.1	100.00%
TOTAL	**1**	**1**	**0**	**0**	**0**	**0**	**0**							

Dall's Sheep Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Cranium	1	0	0	0	0	—	—	—	1	0	1	0	1	100.0%
Radius	1	0	0	1	0	1	0	0	1	0	1	0	0.5	50.0%
TOTAL	**2**	**0**	**0**	**1**	**0**	**1**	**0**							

c.f. Dall's Sheep Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Lumbar Vertebrae	1	0	1	0	0	—	—	—	1	0	1	0	0.2	100.00%
TOTAL	**1**	**0**	**1**	**0**	**0**	—	—							

Caribou Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Cranium	9	—	—	—	—	—	—	—	—	—	—	—	—	—
Antler	3	—	—	—	—	—	—	—	—	—	—	—	—	—
Maxilla	18	0	—	—	0	12	6	0	14	0	11	0	7	53.85%
Mandible	25	0	—	—	0	7	12	1	12	0	7	0	6	46.15%
Hyoid	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Atlas	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Axis	1	0	0	0	0	—	—	—	1	0	1	0	1	7.69%
Cervical Vertebrae	13	—	—	—	—	—	—	—	9	2	3	2	1.8	13.85%
Thoracic Vertebrae	31	1	—	—	13	—	—	—	15	5	1	1	1.2	9.23%
Lumbar Vertebrae	12	1	—	—	4	—	—	—	8	3	1	1	2	15.38%
Caudal Vertebrae	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Caribou Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Vertebrae	10	—	—	—	10	—	—	—	—	—	—	—	—	—
Ribs	98	0	1	21	0	—	—	—	14	0	1	0	0.5	3.85%
Sternum	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scapula	39	1	20	0	2	6	14	19	20	2	11	2	10	76.92%
Humerus	25	0	14	2	2	10	13	2	7	1	4	1	3.5	26.92%
Radius-Ulna	37	0	14	10	1	18	11	8	14	1	9	1	7	53.85%
Radius	19	0	7	12	1	15	4	0	8	1	6	1	4	30.77%
Ulna	22	0	1	21	0	9	10	3	14	0	7	0	7	53.85%
Metacarpal	24	0	10	13	0	4	8	12	8	0	7	0	4	30.77%
Carpals	21	14	0	0	0	13	7	1	20	0	3	0	1.7	13.08%
Innominate	13	0	—	—	0	8	3	2	5	0	4	0	2.5	19.23%
Sacrum	3	0	1	1	1	—	—	—	3	1	3	1	3	23.08%
Femur	27	0	5	4	2	14	11	2	7	2	3	1	3.5	26.92%
Patella	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Tibia	35	0	16	11	1	17	16	2	10	1	6	1	5	38.46%
Lateral Malleolus	13	10	0	1	0	8	5	0	13	0	8	0	6.5	50.00%
Metatarsal	42	0	9	14	0	6	10	26	14	0	8	0	7	53.85%
Calcaneus	29	13	2	10	2	15	11	2	26	2	13	2	13	100.00%
Astragalus	14	11	0	0	0	6	8	0	13	0	7	0	6.5	50.00%
Tarsals	16	10	0	1	0	8	7	1	13	0	5	0	2.2	16.92%
Metapodials	15	0	14	1	0	0	0	15	14	0	14	0	3.5	26.92%
Phalanges	69	43	12	8	0	—	—	—	63	0	5	0	2.6	20.00%
Dew Claw	17	10	0	5	1	—	—	17	17	1	—	—	—	—
Sesamoids	8	8	0	0	0	2	3	3	8	0	2	0	0.3	2.31%
TOTAL	**708**	**122**	**126**	**135**	**40**	**178**	**159**							

c.f. Caribou Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Mandible	1	0	—	—	0	0	1	0	1	0	1	0	0.5	50.00%
Humerus	2	0	0	0	0	1	1	0	2	0	1	0	1	100.00%
Radius-Ulna	1	0	0	1	0	0	1	0	1	0	1	0	0.5	50.00%
Radius	1	0	0	1	0	0	1	0	1	0	1	0	0.5	50.00%
Ulna	1	0	0	1	0	0	1	0	1	0	1	0	0.5	50.00%
Innominate	1	0	—	—	0	0	0	1	1	0	1	0	0.5	50.00%

c.f. Caribou Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
TOTAL	**7**	**0**	**0**	**3**	**0**	**0**	**5**							

Moose Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Cranium	16	0	—	—	0	1	2	13	4	0	1	0	—	—
Antler	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Maxilla	8	0	—	—	—	7	0	1	2	0	2	0	1	12.50%
Mandible	26	0	—	—	0	13	9	4	11	0	6	0	5.5	68.75%
Hyoid	1	0	1	0	0	0	0	1	1	0	1	0	0.5	6.25%
Atlas	4	1	0	0	0	—	—	—	4	0	4	0	4	50.00%
Axis	3	1	0	2	0	—	—	—	3	0	3	0	3	37.50%
Cervical Vertebrae	3	3	—	—	0	—	—	—	3	0	1	0	0.6	7.50%
Thoracic Vertebrae	15	0	—	—	0	—	—	—	10	0	1	0	0.8	10.00%
Lumbar Vertebrae	9	0	—	—	3	—	—	—	6	1	2	1	1	12.50%
Caudal Vertebrae	1	1	—	—	0	—	—	—	1	0	1	0	—	—
Vertebrae	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ribs	59	0	0	15	0	—	—	—	15	0	1	0	0.6	7.50%
Sternum	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scapula	14	0	7	0	0	2	5	7	8	0	5	0	4	50.00%
Humerus	30	0	18	3	2	13	12	5	13	1	7	1	6.5	81.25%
Radius-Ulna	9	0	3	2	0	3	4	2	3	0	2	0	1.5	18.75%
Radius	18	0	4	10	1	8	6	4	8	1	3	1	4	50.00%
Ulna	4	0	0	3	1	3	0	1	3	1	2	1	1.5	18.75%
Metacarpal	35	0	7	16	3	8	6	21	16	3	7	2	8	100.00%
Carpals	34	31	0	0	0	18	14	2	34	0	4	0	2.8	35.00%
Innominate	29	0	0	0	1	13	11	5	5	1	3	1	2.5	31.25%
Sacrum	1	0	0	1	0	—	—	—	1	0	1	0	1	12.50%
Femur	21	0	4	8	5	6	12	2	6	3	3	2	3	37.50%
Patella	1	0	0	0	0	1	0	0	1	0	1	0	0.5	6.25%
Tibia	32	0	17	5	5	15	13	4	13	4	2	6	6.5	81.25%
Lateral Malleolus	3	2	0	0	0	1	1	1	3	0	2	0	1.5	18.75%
Metatarsal	24	0	6	7	1	4	6	14	6	1	4	1	3	37.50%
Calcaneus	7	4	0	0	0	0	7	0	7	0	7	0	7	87.50%
Astragalus	10	8	0	0	0	6	4	0	10	0	6	0	5	62.50%

Moose Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Tarsals	9	6	0	0	0	7	2	0	9	0	6	0	1.5	18.75%
Metapodials	13	0	8	2	1	0	0	13	8	1	2	1	2	25.00%
Phalanges	75	34	13	17	0	—	—	—	66	0	4	0	2.8	35.00%
Dew Claw	8	3	1	3	1	0	0	8	5	1	3	1	2.5	31.25%
Sesamoids	**2**	**2**	**0**	**0**	**0**	—	—	2	2	0	1	0	0.1	1.25%
TOTAL	**524**	**96**	**89**	**94**	**24**	**129**	**114**							

c.f. Moose Skeletal Part	NISP	Complete	Distal	Proximal	Unfused	Left	Right	Indet.	MNE	Juv. MNE	MNI	Juv. MNI	MAU	%MAU
Cervical Vertebrae	1	0	1	0	0	—	—	—	1	0	1	0	0.2	40.00%
Radius-Ulna	1	0	1	0	0	0	1	0	1	0	1	0	0.5	100.00%
Phalanges	1	0	0	1	0	—	—	—	1	0	1	0	0.04	8.00%
Sesamoids	1	1	0	0	0	0	0	1	1	0	1	0	0.04	8.00%
TOTAL	**4**	**1**	**2**	**1**	**0**	**0**	**1**							

Appendix D: List of Scan Sites used for the Density Mediated Attrition Analysis

Caribou					
Element	**Scan Site**	**BMD**	**NISP**	**nNISP**	**%nNISP**
Acetabulum	AC1	0.64	11	5.5	35.5%
Astragalus	AS1	0.68	13	6.5	41.9%
	AS2	0.7	14	7	45.2%
	AS3	0.63	12	6	38.7%
Axis	AX1	0.62	1	1	6.5%
	AX2	0.42	1	1	6.5%
Calcaneus	CA1	0.52	27	13.5	87.1%
	CA2	0.94	27	13.5	87.1%
	CA3	0.66	18	9	58.1%
	CA4	0.73	18	9	58.1%
Cervical Vertebrae	CE1	0.45	9	1.8	11.6%
	CE2	0.43	8	1.6	10.3%
Ulnar Carpal	Cuneiform	0.71	4	2	12.9%
Mandible	DN1	0.65	2	1	6.5%
	DN2	1.05	8	4	25.8%
	DN3	1.07	5	2.5	16.1%
	DN4	1.06	10	5	32.3%
	DN5	1.05	5	2.5	16.1%
	DN6	0.84	4	2	12.9%
	DN7	1.01	1	0.5	3.2%
	DN8	0.99	5	2.5	16.1%
2nd/3rd Tarsal	Ext.-Mid. Cuneiform	0.77	3	1.5	9.7%
Femur	FE1	0.39	4	2	12.9%
	FE2	0.52	6	3	19.4%
	FE4	1.15	4	2	12.9%
	FE5	0.61	10	5	32.3%
	FE6	0.32	9	4.5	29.0%
	FE7	0.3	2	1	6.5%
Humerus	HU1	0.26	3	1.5	9.7%
	HU2	0.44	1	0.5	3.2%
	HU3	1.12	4	2	12.9%
	HU4	1.08	5	2.5	16.1%
	HU5	0.48	15	7.5	48.4%
Ilium	IL1	0.43	2	1	6.5%
	IL2	1.02	5	2.5	16.1%
Ischium	IS1	0.94	4	2	12.9%
Lumbar Vertebrae	LU1	0.49	8	1.3	8.4%
	LU2	0.45	7	1.2	7.7%
	LU3	0.51	4	0.7	4.5%
Intermediate Carpal	Lunate	0.67	5	2.5	16.1%
2nd/3rd Carpal	Magnum	0.69	4	2	12.9%
Metacarpal	MC1	0.92	13	6.2	40.0%
	MC2	1.08	7	3.5	22.6%
	MC3	1.1	1	0.5	3.2%

Caribou					
Element	**Scan Site**	**BMD**	**NISP**	**nNISP**	**%nNISP**
	MC6	0.68	10	5	32.3%
Metatarsal	MR1	0.9	15	7.5	48.4%
	MR2	1.1	8	4	25.8%
	MR3	1.08	20	10	64.5%
	MR4	1.08	1	0.5	3.2%
	MR5	0.41	9	4.5	29.0%
	MR6	0.59	9	4.5	29.0%
Central/4th Tarsal	NC1	0.56	9	4.5	29.0%
	NC2	0.62	10	5	32.3%
	NC3	0.55	10	5	32.3%
First Phalanx	P1-1	0.48	31	3.9	25.2%
	P1-2	0.92	27	3.4	21.9%
	P1-3	0.71	36	4.5	29.0%
Second Phalanx	P2-1	0.61	15	1.8	11.6%
	P2-2	0.72	16	2	12.9%
Third Phalanx	P3-1	0.48	11	1.3	8.4%
Pubis	PU1	0.58	1	0.5	3.2%
Radius	RA1	0.53	21	10.5	67.7%
	RA2	1.08	9	4.5	29.0%
	RA3	1.09	13	6.5	41.9%
	RA4	0.97	5	2.5	16.1%
	RA5	0.49	22	10.5	67.7%
Rib	RI1	0.47	1	0.04	0.3%
	RI2	0.49	21	0.8	5.2%
	RI3	0.96	1	0.04	0.3%
	RI4	0.94	76	2.9	18.7%
	RI5	0.4	1	0.04	0.3%
Sacrum	SC1	0.37	3	3	19.4%
Radial Carpal	Scaphoid	0.7	4	2	12.9%
Scapula	SP1	1.01	18	9	58.1%
	SP2	1.04	12	6	38.7%
	SP3	0.73	14	7	45.2%
	SP4	1.01	13	6.5	41.9%
	SP5	0.48	5	2.5	16.1%
Thoracic Vertebrae	TH1	0.38	30	2.3	14.8%
	TH2	0.53	9	0.7	4.5%
Tibia	TI1	0.35	12	6	38.7%
	TI2	1.01	2	1	6.5%
	TI3	1.13	6	3	19.4%
	TI5	0.73	16	8	51.6%
Ulna	UL1	0.49	6	3	19.4%
	UL2	0.84	29	15.5	100.0%
4th Carpal	Uniform	0.72	4	2	12.9%

Caribou North Area					
Element	**Scan Site**	**BMD**	**NISP**	**nNISP**	**%nNISP**
Acetabulum	AC1	0.64	7	3.5	36.8%
Astragalus	AS1	0.68	7	3.5	36.8%
	AS2	0.7	8	4	42.1%
	AS3	0.63	6	3	31.6%
Calcaneus	CA1	0.52	18	9	94.7%
	CA2	0.94	18	8.5	89.5%
	CA3	0.66	9	4.5	47.4%
	CA4	0.73	9	4.5	47.4%
Cervical Vertebrae	CE1	0.45	4	0.8	8.4%
	CE2	0.43	4	0.8	8.4%
Ulnar Carpal	Cuneiform	0.71	2	1	10.5%
Mandible	DN1	0.65	1	0.5	5.3%
	DN2	1.05	3	1.5	15.8%
	DN3	1.07	2	1	10.5%
	DN4	1.06	3	1.5	15.8%
	DN5	1.05	4	2	21.1%
	DN6	0.84	3	1.5	15.8%
	DN7	1.01	1	0.1	1.1%
	DN8	0.99	2	1	10.5%
2nd/3rd Tarsal	Ext.-Mid. Cuneiform	0.77	1	0.5	5.3%
Femur	FE5	0.61	3	1.5	15.8%
	FE6	0.32	5	2.5	26.3%
Humerus	HU1	0.26	2	1	10.5%
	HU3	1.12	1	0.5	5.3%
	HU5	0.48	6	3	31.6%
Ilium	IL1	0.43	1	0.5	5.3%
	IL2	1.02	3	1.5	15.8%
Ischium	IS1	0.94	3	1.5	15.8%
Lumbar Vertebrae	LU1	0.49	7	1.2	12.6%
	LU2	0.45	5	0.8	8.4%
	LU3	0.51	4	0.7	7.4%
Intermediate Carpal	Lunate	0.67	3	1.5	15.8%
2nd/3rd Carpal	Magnum	0.69	2	1	10.5%
Metacarpal	MC1	0.92	9	4.5	47.4%
	MC2	1.08	4	2	21.1%
	MC6	0.68	8	4	42.1%
Metatarsal	MR1	0.9	9	4.5	47.4%
	MR2	1.1	4	2	21.1%

Caribou North Area					
Element	**Scan Site**	**BMD**	**NISP**	**nNISP**	**%nNISP**
	MR3	1.08	11	5.5	57.9%
	MR4	1.08	1	0.5	5.3%
	MR5	0.41	8	4	42.1%
	MR6	0.59	8	4	42.1%
Central/4th Tarsal	NC1	0.56	3	2.5	26.3%
	NC2	0.62	3	2	21.1%
	NC3	0.55	4	1	10.5%
First Phalanx	P1-1	0.48	14	1.2	12.6%
	P1-2	0.92	11	1.4	14.7%
	P1-3	0.71	14	1.8	18.9%
Second Phalanx	P2-1	0.61	7	0.9	9.5%
	P2-2	0.72	9	1.2	12.6%
Third Phalanx	P3-1	0.48	6	0.7	7.4%
Pubis	PU1	0.58	1	0.5	5.3%
Radius	RA1	0.53	12	6	63.2%
	RA2	1.08	4	2	21.1%
	RA3	1.09	10	5	52.6%
	RA4	0.97	3	1.5	15.8%
	RA5	0.49	16	8	84.2%
Rib	RI2	0.49	14	0.5	5.3%
	RI4	0.94	45	1.7	17.9%
Sacrum	SC1	0.37	1	1	10.5%
Scapula	SP1	1.01	9	4.5	47.4%
	SP2	1.04	5	2.5	26.3%
	SP3	0.73	7	3.5	36.8%
	SP4	1.01	7	3.5	36.8%
	SP5	0.48	3	1.5	15.8%
Thoracic Vertebrae	TH1	0.38	17	1.3	13.7%
	TH2	0.53	4	0.3	3.2%
Tibia	TI1	0.35	4	2	21.1%
	TI2	1.01	1	0.5	5.3%
	TI3	1.13	1	0.5	5.3%
	TI5	0.73	8	4	42.1%
Ulna	UL1	0.49	2	1	10.5%
	UL2	0.84	19	9.5	100.0%
4th Carpal	Uniform	0.72	4	2	21.1%

Caribou South Area					
Element	**Scan Site**	**BMD**	**NISP**	**nNISP**	**%nNISP**
Acetabulum	AC1	0.64	4	2	44.4%
Astragalus	AS1	0.68	6	3	66.7%
	AS2	0.7	6	3	66.7%
	AS3	0.63	6	3	66.7%
Axis	AX1	0.62	1	1	22.2%
	AX2	0.42	1	1	22.2%
Calcaneus	CA1	0.52	9	4.5	100.0%
	CA2	0.94	9	4.5	100.0%
	CA3	0.66	9	4.5	100.0%
	CA4	0.73	9	4.5	100.0%
Cervical Vertebrae	CE1	0.45	5	1	22.2%
	CE2	0.43	4	0.8	17.8%
Ulnar Carpal	Cuneiform	0.71	2	1	22.2%
Mandible	DN1	0.65	1	0.5	11.1%
	DN2	1.05	5	2.5	55.6%
	DN3	1.07	3	1.5	33.3%
	DN4	1.06	7	3.5	77.8%
	DN5	1.05	1	0.5	11.1%
	DN6	0.84	1	0.5	11.1%
	DN8	0.99	3	1.5	33.3%
2nd/3rd Tarsal	Ext.-Mid. Cuneiform	0.77	2	1	22.2%
Femur	FE1	0.39	4	2	44.4%
	FE2	0.52	6	3	66.7%
	FE4	1.15	4	2	44.4%
	FE5	0.61	7	3.5	77.8%
	FE6	0.32	4	2	44.4%
	FE7	0.3	2	1	22.2%
Humerus	HU1	0.26	1	0.5	11.1%
	HU2	0.44	1	0.5	11.1%
	HU3	1.12	3	1.5	33.3%
	HU4	1.08	5	2.5	55.6%
	HU5	0.48	9	4.5	100.0%
Ilium	IL1	0.43	1	0.5	11.1%
	IL2	1.02	2	1	22.2%
Ischium	IS1	0.94	1	0.5	11.1%
Lumbar Vertebrae	LU1	0.49	1	0.2	4.4%
	LU2	0.45	2	0.3	6.7%
Intermediate Carpal	Lunate	0.67	2	1	22.2%
2nd/3rd Carpal	Magnum	0.69	2	1	22.2%

Caribou South Area					
Element	**Scan Site**	**BMD**	**NISP**	**nNISP**	**%nNISP**
Metacarpal	MC1	0.92	4	2	44.4%
	MC2	1.08	3	1.5	33.3%
	MC3	1.1	1	0.5	11.1%
	MC6	0.68	2	1	22.2%
Metatarsal	MR1	0.9	6	3	66.7%
	MR2	1.1	4	2	44.4%
	MR3	1.08	9	4.5	100.0%
	MR5	0.41	1	0.5	11.1%
	MR6	0.59	1	0.5	11.1%
Central/4th Tarsal	NC1	0.56	6	3	66.7%
	NC2	0.62	7	3.5	77.8%
	NC3	0.55	6	3	66.7%
First Phalanx	P1-1	0.48	17	2.1	46.7%
	P1-2	0.92	16	2	44.4%
	P1-3	0.71	22	2.8	62.2%
Second Phalanx	P2-1	0.61	8	1	22.2%
	P2-2	0.72	7	0.9	20.0%
Third Phalanx	P3-1	0.48	5	0.6	13.3%
Radius	RA1	0.53	9	4.5	100.0%
	RA2	1.08	5	2.5	55.6%
	RA3	1.09	3	1.5	33.3%
	RA4	0.97	2	2	44.4%
	RA5	0.49	6	3	66.7%
Rib	RI1	0.47	1	0.04	0.9%
	RI2	0.49	7	0.3	6.7%
	RI3	0.96	1	0.04	0.9%
	RI4	0.94	31	1.2	26.7%
	RI5	0.4	1	0.04	0.9%
Sacrum	SC1	0.37	2	2	44.4%
Radial Carpal	Scaphoid	0.7	4	2	44.4%
Scapula	SP1	1.01	9	4.5	100.0%
	SP2	1.04	7	3.5	77.8%
	SP3	0.73	7	3.5	77.8%
	SP4	1.01	6	2.5	55.6%
	SP5	0.48	2	1	22.2%
Thoracic Vertebrae	TH1	0.38	13	1	22.2%
	TH2	0.53	5	0.4	8.9%
Tibia	TI1	0.35	8	4	88.9%
	TI2	1.01	1	0.5	11.1%

Caribou South Area					
Element	**Scan Site**	**BMD**	**NISP**	**nNISP**	**%nNISP**
	TI3	1.13	5	2.5	55.6%
	TI5	0.73	8	4	88.9%
Ulna	UL1	0.49	4	2	44.4%
	UL2	0.84	10	3	66.7%

Moose					
Element	**Scan Site**	**BMD**	**NISP**	**nNISP**	**%nNISP**
Acetabulum	AC1	0.64	16	8	84.2%
Astragalus	AS1	0.68	10	5	52.6%
	AS2	0.7	10	5	52.6%
	AS3	0.63	9	4.5	47.4%
Atlas	AT1	0.47	2	2	21.1%
	AT2	0.42	2	2	21.1%
	AT3	0.49	2	2	21.1%
Axis	AX1	0.62	4	4	42.1%
	AX2	0.42	1	1	10.5%
	AX1	0.42	1	1	10.5%
Calcaneus	CA1	0.52	7	3.5	36.8%
	CA2	0.94	7	3.5	36.8%
	CA3	0.66	7	3.5	36.8%
	CA4	0.73	7	3.5	36.8%
Cervical Vertebrae	CE1	0.45	3	0.6	6.3%
	CE2	0.43	2	0.4	4.2%
Ulnar Carpal	Cuneiform	0.71	3	1.5	15.8%
Mandible	DN1	0.65	4	2	21.1%
	DN2	1.05	11	5.5	57.9%
	DN3	1.07	13	6.5	68.4%
	DN4	1.06	11	5.5	57.9%
	DN5	1.05	5	2.5	26.3%
	DN7	1.01	4	2	21.1%
	DN8	0.99	1	0.5	5.3%
2nd/3rd Tarsal	Ext-Med Cuneiform	0.77	1	0.5	5.3%
Femur	FE1	0.39	2	1	10.5%
	FE2	0.52	2	1	10.5%
	FE4	1.15	8	4	42.1%
	FE5	0.61	11	5.5	57.9%
	FE6	0.32	5	2.5	26.3%
	FE7	0.3	2	1	10.5%
Humerus	HU1	0.26	3	1.5	15.8%
	HU2	0.44	3	1.5	15.8%
	HU3	1.12	5	2.5	26.3%
	HU4	1.08	5	2.5	26.3%
	HU5	0.48	19	9.5	100.0%
Ilium	IL1	0.43	10	5	52.6%
	IL2	1.02	5	2.5	26.3%
Ischium	IS1	0.94	3	1.5	15.8%
	IS2	0.3	1	0.5	5.3%
Lumbar Vertebrae	LU1	0.49	6	1	10.5%
	LU2	0.45	8	1.3	13.7%
	LU3	0.51	1	0.2	2.1%
Intermediate Carpal	Lunate	0.67	8	2	21.1%
2nd/3rd Carpal	Magnum	0.69	7	3.5	36.8%
Metacarpal	MC1	0.92	16	8	84.2%

Moose					
Element	**Scan Site**	**BMD**	**NISP**	**nNISP**	**%nNISP**
	MC2	1.08	12	6	63.2%
	MC3	1.1	12	6	63.2%
	MC5	0.48	7	3.5	36.8%
	MC6	0.68	7	3.5	36.8%
Metatarsal	MR1	0.9	9	4.5	47.4%
	MR2	1.1	8	4	42.1%
	MR3	1.08	9	4.5	47.4%
	MR5	0.41	6	3	31.6%
	MR6	0.59	6	3	31.6%
Central/4th Tarsal	NC1	0.56	7	3.5	36.8%
	NC2	0.62	8	4	42.1%
	NC3	0.55	8	4	42.1%
First Phalanx	P1-1	0.48	24	3	31.6%
	P1-2	0.92	18	2.3	24.2%
	P1-3	0.71	28	3.5	36.8%
Second Phalanx	P2-1	0.61	29	3.6	37.9%
	P2-2	0.72	27	3.4	35.8%
Third Phalanx	P3-1	0.48	9	1.1	11.6%
Patella	PA1	0.57	1	0.5	5.3%
Pubis	PU1	0.58	3	1.5	15.8%
Radius	RA1	0.53	14	7	73.7%
	RA2	1.08	4	2	21.1%
	RA3	1.09	5	2.5	26.3%
	RA4	0.97	2	1	10.5%
	RA5	0.49	5	2.5	26.3%
Rib	RI1	0.47	11	0.4	4.2%
	RI2	0.49	12	0.5	5.3%
	RI3	0.96	2	0.08	0.8%
	RI4	0.94	42	1.6	16.8%
Sacrum	SC1	0.37	1	1	10.5%
Radial Carpal	Scaphoid	0.7	7	3.5	36.8%
Scapula	SP1	1.01	8	4	42.1%
	SP2	1.04	2	1	10.5%
	SP3	0.73	4	2	21.1%
	SP4	1.01	4	2	21.1%
Thoracic Vertebrae	TH1	0.38	12	0.9	9.5%
	TH2	0.53	11	0.8	8.4%
Tibia	TI1	0.35	15	7.5	78.9%
	TI2	1.01	5	2.5	26.3%
	TI3	1.13	9	4.5	47.4%
	TI4	1.12	4	2	21.1%
	TI5	0.73	9	4.5	47.4%
Ulna	UL1	0.49	3	0.5	5.3%
	UL2	0.84	3	1.5	15.8%
4th Carpal	Unciform	0.72	7	3.5	36.8%

Moose North Area					
Element	**Scan Site**	**BMD**	**NISP**	**nNISP**	**%nNISP**
Acetabulum	AC1	0.64	1	0.5	25.0%
Astragalus	AS1	0.68	2	1	50.0%
	AS2	0.7	2	1	50.0%
	AS3	0.63	2	1	50.0%
Atlas	AT1	0.47	1	1	50.0%
	AT2	0.42	1	1	50.0%
	AT3	0.49	2	2	100.0%
Axis	AX1	0.62	1	1	50.0%
	AX2	0.42	1	1	50.0%
	AX3	0.42	1	1	50.0%
Ulnar Carpal	Cuneiform	0.71	1	0.5	25.0%
Mandible	DN2	1.05	1	0.5	25.0%
	DN3	1.07	2	1	50.0%
	DN4	1.06	2	1	50.0%
	DN5	1.05	2	1	50.0%
	DN7	1.01	1	0.5	25.0%
Femur	FE4	1.15	2	1	50.0%
	FE5	0.61	2	1	50.0%
	FE6	0.32	1	0.5	25.0%
Humerus	HU2	0.44	1	0.5	25.0%
	HU5	0.48	2	1	50.0%
Ilium	IL1	0.43	2	1	50.0%
	IL2	1.02	1	0.5	25.0%
Intermediate Carpal	LU2	0.45	1	0.2	10.0%
	Lunate	0.67	1	0.5	25.0%
2nd/3rd Carpal	Magnum	0.69	1	0.5	25.0%
Metacarpal	MC3	1.1	4	2	100.0%
	MC5	0.48	1	0.5	25.0%
	MC6	0.68	1	0.5	25.0%
Metatarsal	MR3	1.08	1	0.5	25.0%
	MR5	0.41	1	0.5	25.0%
	MR6	0.59	1	0.5	25.0%
First Phalanx	P1-1	0.48	1	0.1	5.0%
	P1-2	0.92	1	0.1	5.0%
	P1-3	0.71	1	0.1	5.0%
Second Phalanx	P2-1	0.61	3	0.4	20.0%
	P2-2	0.72	2	0.3	15.0%
Third Phalanx	P3-1	0.48	1	0.1	5.0%
Radius	RA1	0.53	2	1	50.0%
	RA3	1.09	1	0.5	25.0%
	RA5	0.49	3	1.5	75.0%
Rib	RI1	0.47	2	0.08	4.0%
	RI2	0.49	5	0.2	10.0%
	RI4	0.94	14	0.5	25.0%
Radial Carpal	Scaphoid	0.7	2	1	50.0%
Scapula	SP1	1.01	2	1	50.0%

Moose North Area					
Element	**Scan Site**	**BMD**	**NISP**	**nNISP**	**%nNISP**
	SP3	0.73	2	1	50.0%
Thoracic Vertebrae	TH1	0.38	5	0.3	15.0%
	TH2	0.53	4	0.3	15.0%
Tibia	TI1	0.35	2	1	50.0%
	TI4	1.12	1	0.5	25.0%
	TI5	0.73	2	1	50.0%
Ulna	UL1	0.49	1	0.5	25.0%
	UL2	0.84	1	0.5	25.0%
4th Carpal	Unciform	0.72	3	1.5	75.0%

Moose South Area					
Element	**Scan Site**	**BMD**	**NISP**	**nNISP**	**%nNISP**
Acetabulum	AC1	0.64	15	7.5	88.2%
Astragalus	AS1	0.68	8	4	47.1%
	AS2	0.7	8	4	47.1%
	AS3	0.63	7	3.5	41.2%
Atlas	AT1	0.47	1	1	11.8%
	AT2	0.42	1	1	11.8%
Axis	AX1	0.62	3	3	35.3%
Calcaneus	CA1	0.52	7	3.5	41.2%
	CA2	0.94	7	3.5	41.2%
	CA3	0.66	7	3.5	41.2%
	CA4	0.73	7	3.5	41.2%
Cervical Vertebrae	CE1	0.45	3	0.6	7.1%
	CE2	0.43	2	0.4	4.7%
Ulnar Carpal	Cuneiform	0.71	2	1	11.8%
Mandible	DN1	0.65	4	2	23.5%
	DN2	1.05	10	5	58.8%
	DN3	1.07	11	5.5	64.7%
	DN4	1.06	9	4.5	52.9%
	DN5	1.05	3	1.5	17.6%
	DN7	1.01	3	1.5	17.6%
	DN8	0.99	1	0.5	5.9%
2nd/3rd Tarsal	Ext-Med Cuneiform	0.77	1	0.5	5.9%
Femur	FE1	0.39	2	1	11.8%
	FE2	0.52	2	1	11.8%
	FE4	1.15	6	3	35.3%
	FE5	0.61	9	4.5	52.9%
	FE6	0.32	4	2	23.5%
	FE7	0.3	2	1	11.8%
Humerus	HU1	0.26	3	1.5	17.6%
	HU2	0.44	2	1	11.8%
	HU3	1.12	5	2.5	29.4%
	HU4	1.08	5	2.5	29.4%
	HU5	0.48	17	8.5	100.0%
Ilium	IL1	0.43	8	4	47.1%
	IL2	1.02	4	2	23.5%
Ischium	IS1	0.94	3	1.5	17.6%
	IS2	0.3	1	0.5	5.9%
Lumbar Vertebrae	LU1	0.49	6	1	11.8%
	LU2	0.45	7	1.2	14.1%
	LU3	0.51	1	0.2	2.4%
Intermediate Carpal	Lunate	0.67	7	3.5	41.2%
2nd/3rd Carpal	Magnum	0.69	6	3	35.3%
Metacarpal	MC1	0.92	16	8	94.1%
	MC2	1.08	12	6	70.6%
	MC3	1.1	8	4	47.1%
	MC5	0.48	6	3	35.3%

Moose South Area					
Element	**Scan Site**	**BMD**	**NISP**	**nNISP**	**%nNISP**
	MC6	0.68	6	3	35.3%
Metatarsal	MR1	0.9	9	4.5	52.9%
	MR2	1.1	8	4	47.1%
	MR3	1.08	8	4	47.1%
	MR5	0.41	5	2.5	29.4%
	MR6	0.59	5	2.5	29.4%
Central/4th Tarsal	NC1	0.56	7	3.5	41.2%
	NC2	0.62	8	4	47.1%
	NC3	0.55	8	4	47.1%
First Phalanx	P1-1	0.48	23	2.9	34.1%
	P1-2	0.92	17	2.1	24.7%
	P1-3	0.71	27	3.4	40.0%
Second Phalanx	P2-1	0.61	26	3.3	38.8%
	P2-2	0.72	25	3.1	36.5%
Third Phalanx	P3-1	0.48	8	1	11.8%
Patella	PA1	0.57	1	0.5	5.9%
Pubis	PU1	0.58	3	1.5	17.6%
Radius	RA1	0.53	12	6	70.6%
	RA2	1.08	4	2	23.5%
	RA3	1.09	4	2	23.5%
	RA4	0.97	2	1	11.8%
	RA5	0.49	2	1	11.8%
Rib	RI1	0.47	9	0.3	3.5%
	RI2	0.49	7	0.3	3.5%
	RI3	0.96	2	0.07	0.8%
	RI4	0.94	28	1.1	12.9%
Sacrum	SC1	0.37	1	1	11.8%
Radial Carpal	Scaphoid	0.7	5	2.5	29.4%
Scapula	SP1	1.01	6	3	35.3%
	SP2	1.04	2	1	11.8%
	SP3	0.73	2	1	11.8%
	SP4	1.01	4	2	23.5%
Thoracic Vertebrae	TH1	0.38	7	0.5	5.9%
	TH2	0.53	7	0.5	5.9%
Tibia	TI1	0.35	13	6.5	76.5%
	TI2	1.01	5	2.5	29.4%
	TI3	1.13	9	4.5	52.9%
	TI4	1.12	3	1.5	17.6%
	TI5	0.73	7	3.5	41.2%
Ulna	UL1	0.49	2	1	11.8%
	UL2	0.84	2	1	11.8%
4th Carpal	Unciform	0.72	4	2	23.5%

Appendix E: Utility Index Analysis Values

Tables are based on Morin and Ready's (2013) Utility Index Table 14.6.

Caribou							
Element	**nNISP**	**MUI (g)**	**FUI**	**CFUI**	**Grease**	**UMI (ml)**	**MDI**
Cranium*	13.5	937.0 (469.0)	235.0	937.0 (469.0)	—	—	1.9
Mandible (with tongue)	12.5	1600.0	—	1600.0	12.5	—	66.4
Mandible (w/o tongue)	12.5	590.0	590.0	590.0	12.5	—	56.2
Atlas-axis	0.5	524.0	524.0	524.0	13.0	—	88.2
Cervicals 3-7	2.6	1905.0	1905.0	1905.0	17.5	—	186.7
Thoracic	2.4	2433.0	2433.0	2433.0	12.3	—	311.3
Lumbar	2	1706.0	1706.0	1706.0	14.8	—	205.8
Pelvis+Sacrum	8	2531.0	2531.0	2531.0	29.3	—	196.8
Ribs	3.8	2650.0	2650.0	2650.0	7.5	—	745.4
Sternum	0	—	3422.0	—	26.0	—	—
Scapula	19.5	2295.0	2295.0	2295.0	7.7	—	89.5
Humerus	12.5	1486.0	1891.0	2093.0	51.7	22.8	18.5
Radio-Ulna	39	755.0	1323.0	1181.0	35.1	26.3	16.4
Carpals	1.8	—	—	653.0	36.5	0.9	—
Metacarpal	12	268.0	—	413.0	29.6	19.6	15.5
Metacarpals+ Carpals	3.2	—	795.0	—	—	—	—
Femur	13.5	5139.0	5139.0	5139.0	63.5	34.0	17.0
Tibia	17.5	1310.0	—	2746.0	47.7	51.1	13.0
Tarsals	6.7	—	—	1424.0	36.4	4.4	—
Tibia+Tarsals	6.4	—	3225.0	—	—	—	—
Metatarsal	21	581.0	1903.0	897.0	30.5	46.5	11.2
Phalanx 1	5	21.0	—	99.6	33.3	3.7	15.1
Phalanx 2	2.3	16.3	—	77.5	24.8	1.8	11.8
Phalanx 3	1.4	9.3	—	44.3	13.6	0.9	6.7
Phalanges (set of 3)	2.9	46.7	998.0	221.0	23.9	6.4	33.6
All cervicals	2	2429.0	—	2429.0	14.5	—	277.3
All vertebrae	2.2	6568.0	—	6568.0	14.1	—	794.4

Caribou North Excavation Area							
Element	**nNISP**	**MUI (g)**	**FUI**	**CFUI**	**Grease**	**UMI (ml)**	**MDI**
Cranium*	5	937.0 (469.0)	235.0	937.0 (469.0)	–	–	1.9
Mandible (with tongue)	5	1600.0	–	1600.0	12.5	–	66.4
Mandible (w/o tongue)	5	590.0	590.0	590.0	12.5	–	56.2
Atlas-axis	0	524.0	524.0	524.0	13.0	–	88.2
Cervicals 3-7	1.2	1905.0	1905.0	1905.0	17.5	–	186.7
Thoracic	1.3	2433.0	2433.0	2433.0	12.3	–	311.3
Lumbar	1.5	1706.0	1706.0	1706.0	14.8	–	205.8
Pelvis+Sacrum	3	2531.0	2531.0	2531.0	29.3	–	196.8
Ribs	2.3	2650.0	2650.0	2650.0	7.5	–	745.4
Sternum	0	–	3422.0	–	26.0	–	–
Scapula	8.5	2295.0	2295.0	2295.0	7.7	–	89.5
Humerus	4.5	1486.0	1891.0	2093.0	51.7	22.8	18.5
Radio-Ulna	26.5	755.0	1323.0	1181.0	35.1	26.3	16.4
Carpals	0.9	–	–	653.0	36.5	0.9	–
Metacarpal	8.5	268.0	–	413.0	29.6	19.6	15.5
Metacarpals+ Carpals	2	–	795.0	–	–	–	–
Femur	3	5139.0	5139.0	5139.0	63.5	34.0	17.0
Tibia	7	1310.0	–	2746.0	47.7	51.1	13.0
Tarsals	1.2	–	–	1424.0	36.4	4.4	–
Tibia+Tarsals	2.6	–	3225.0	–	–	–	–
Metatarsal	13	581.0	1903.0	897.0	30.5	46.5	11.2
Phalanx 1	2.1	21.0	–	99.6	33.3	3.7	15.1
Phalanx 2	1.3	16.3	–	77.5	24.8	1.8	11.8
Phalanx 3	0.1	9.3	–	44.3	13.6	0.9	6.7
Phalanges (set of 3)	1.4	46.7	998.0	221.0	23.9	6.4	33.6
All cervicals	1.2	2429.0	–	2429.0	14.5	–	277.3
All vertebrae	1.2	6568.0	–	6568.0	14.1	–	794.4

Caribou Southern Excavation Area							
Element	**nNISP**	**MUI (g)**	**FUI**	**CFUI**	**Grease**	**UMI (ml)**	**MDI**
Cranium*	8.5	937.0 (469.0)	235.0	937.0 (469.0)	–	–	1.9
Mandible (with tongue)	7.5	1600.0	–	1600.0	12.5	–	66.4
Mandible (w/o tongue)	7.5	590.0	590.0	590.0	12.5	–	56.2
Atlas-axis	1	524.0	524.0	524.0	13.0	–	88.2
Cervicals 3-7	1	1905.0	1905.0	1905.0	17.5	–	186.7
Thoracic	1.4	2433.0	2433.0	2433.0	12.3	–	311.3
Lumbar	1.1	1706.0	1706.0	1706.0	14.8	–	205.8
Pelvis+Sacrum	2.3	2531.0	2531.0	2531.0	29.3	–	196.8
Ribs	1.5	2650.0	2650.0	2650.0	7.5	–	745.4
Sternum		–	3422.0	–	26.0	–	–
Scapula	11	2295.0	2295.0	2295.0	7.7	–	89.5
Humerus	8	1486.0	1891.0	2093.0	51.7	22.8	18.5
Radio-Ulna	12.5	755.0	1323.0	1181.0	35.1	26.3	16.4
Carpals	0.8	–	–	653.0	36.5	0.9	–
Metacarpal	3.5	268.0	–	413.0	29.6	19.6	15.5
Metacarpals+ Carpals	1.2	–	795.0	–	–	–	–
Femur	10.5	5139.0	5139.0	5139.0	63.5	34.0	17.0
Tibia	10.5	1310.0	–	2746.0	47.7	51.1	13.0
Tarsals	1.5	–	–	1424.0	36.4	4.4	–
Tibia+Tarsals	15	–	3225.0	–	–	–	–
Metatarsal	8	581.0	1903.0	897.0	30.5	46.5	11.2
Phalanx 1	2.9	21.0	–	99.6	33.3	3.7	15.1
Phalanx 2	1	16.3	–	77.5	24.8	1.8	11.8
Phalanx 3	0.6	9.3	–	44.3	13.6	0.9	6.7
Phalanges (set of 3)	1.5	46.7	998.0	221.0	23.9	6.4	33.6
All cervicals	1.1	2429.0	–	2429.0	14.5	–	277.3
All vertebrae	1	6568.0	–	6568.0	14.1	–	794.4

Moose							
Element	**nNISP**	**MUI (g)**	**FUI**	**CFUI**	**Grease**	**UMI (ml)**	**MDI**
Cranium*	12	937.0 (469.0)	235.0	937.0 (469.0)	–	–	1.9
Mandible (with tongue)	13	1600.0	–	1600.0	12.5	–	66.4
Mandible (w/o tongue)	13	590.0	590.0	590.0	12.5	–	56.2
Atlas-axis	3.5	524.0	524.0	524.0	13.0	–	88.2
Cervicals 3-7	0.6	1905.0	1905.0	1905.0	17.5	–	186.7
Thoracic	1.2	2433.0	2433.0	2433.0	12.3	–	311.3
Lumbar	1.5	1706.0	1706.0	1706.0	14.8	–	205.8
Pelvis+Sacrum	15	2531.0	2531.0	2531.0	29.3	–	196.8
Ribs	2.3	2650.0	2650.0	2650.0	7.5	–	745.4
Sternum	0	–	3422.0	–	26.0	–	–
Scapula	7	2295.0	2295.0	2295.0	7.7	–	89.5
Humerus	15	1486.0	1891.0	2093.0	51.7	22.8	18.5
Radio-Ulna	15.5	755.0	1323.0	1181.0	35.1	26.3	16.4
Carpals	2.8	–	–	653.0	36.5	0.9	–
Metacarpal	17.5	268.0	–	413.0	29.6	19.6	15.5
Metacarpals+ Carpals	4.9	–	795.0	–	–	–	–
Femur	10.5	5139.0	5139.0	5139.0	63.5	34.0	17.0
Tibia	16	1310.0	–	2746.0	47.7	51.1	13.0
Tarsals	1.5	–	–	1424.0	36.4	4.4	–
Tibia+Tarsals	5.1	–	3225.0	–	–	–	–
Metatarsal	12	581.0	1903.0	897.0	30.5	46.5	11.2
Phalanx 1	4.3	21.0	–	99.6	33.3	3.7	15.1
Phalanx 2	4	16.3	–	77.5	24.8	1.8	11.8
Phalanx 3	1.1	9.3	–	44.3	13.6	0.9	6.7
Phalanges (set of 3)	3.1	46.7	998.0	221.0	23.9	6.4	33.6
All cervicals	1.4	2429.0	–	2429.0	14.5	–	277.3
All vertebrae	1.3	6568.0	–	6568.0	14.1	–	794.4

Moose Northern Excavation Area							
Element	**nNISP**	**MUI (g)**	**FUI**	**CFUI**	**Grease**	**UMI (ml)**	**MDI**
Cranium*	2	937.0 (469.0)	235.0	937.0 (469.0)	–	–	1.9
Mandible (with tongue)	2	1600.0	–	1600.0	12.5	–	66.4
Mandible (w/o tongue)	2	590.0	590.0	590.0	12.5	–	56.2
Atlas-axis	1.5	524.0	524.0	524.0	13.0	–	88.2
Cervicals 3-7	0	1905.0	1905.0	1905.0	17.5	–	186.7
Thoracic	0.4	2433.0	2433.0	2433.0	12.3	–	311.3
Lumbar	0.2	1706.0	1706.0	1706.0	14.8	–	205.8
Pelvis+Sacrum	1.5	2531.0	2531.0	2531.0	29.3	–	196.8
Ribs	0.7	2650.0	2650.0	2650.0	7.5	–	745.4
Sternum	0	–	3422.0	–	26.0	–	–
Scapula	2	2295.0	2295.0	2295.0	7.7	–	89.5
Humerus	1.5	1486.0	1891.0	2093.0	51.7	22.8	18.5
Radio-Ulna	3.5	755.0	1323.0	1181.0	35.1	26.3	16.4
Carpals	0.8	–	–	653.0	36.5	0.9	–
Metacarpal	2.5	268.0	–	413.0	29.6	19.6	15.5
Metacarpals+ Carpals	1	–	795.0	–	–	–	–
Femur	1.5	5139.0	5139.0	5139.0	63.5	34.0	17.0
Tibia	2	1310.0	–	2746.0	47.7	51.1	13.0
Tarsals	0	–	–	1424.0	36.4	4.4	–
Tibia+Tarsals	2	–	3225.0	–	–	–	–
Metatarsal	1	581.0	1903.0	897.0	30.5	46.5	11.2
Phalanx 1	0.1	21.0	–	99.6	33.3	3.7	15.1
Phalanx 2	0.4	16.3	–	77.5	24.8	1.8	11.8
Phalanx 3	0.1	9.3	–	44.3	13.6	0.9	6.7
Phalanges (set of 3)	0.2	46.7	998.0	221.0	23.9	6.4	33.6
All cervicals	1.5	2429.0	–	2429.0	14.5	–	277.3
All vertebrae	0.3	6568.0	–	6568.0	14.1	–	794.4

Moose Southern Excavation Area							
Element	**nNISP**	**MUI (g)**	**FUI**	**CFUI**	**Grease**	**UMI (ml)**	**MDI**
Cranium*	11	937.0 (469.0)	235.0	937.0 (469.0)	–	–	1.9
Mandible (with tongue)	11	1600.0	–	1600.0	12.5	–	66.4
Mandible (w/o tongue)	11	590.0	590.0	590.0	12.5	–	56.2
Atlas-axis	2	524.0	524.0	524.0	13.0	–	88.2
Cervicals 3-7	0.6	1905.0	1905.0	1905.0	17.5	–	186.7
Thoracic	0.8	2433.0	2433.0	2433.0	12.3	–	311.3
Lumbar	1.3	1706.0	1706.0	1706.0	14.8	–	205.8
Pelvis+Sacrum	9	2531.0	2531.0	2531.0	29.3	–	196.8
Ribs	1.5	2650.0	2650.0	2650.0	7.5	–	745.4
Sternum	0	–	3422.0	–	26.0	–	–
Scapula	5	2295.0	2295.0	2295.0	7.7	–	89.5
Humerus	13.5	1486.0	1891.0	2093.0	51.7	22.8	18.5
Radio-Ulna	3	755.0	1323.0	1181.0	35.1	26.3	16.4
Carpals	0.5	–	–	653.0	36.5	0.9	–
Metacarpal	15	268.0	–	413.0	29.6	19.6	15.5
Metacarpals+ Carpals	3.9	–	795.0	–	–	–	–
Femur	9	5139.0	5139.0	5139.0	63.5	34.0	17.0
Tibia	14	1310.0	–	2746.0	47.7	51.1	13.0
Tarsals	1.5	–	–	1424.0	36.4	4.4	–
Tibia+Tarsals	4.6	–	3225.0	–	–	–	–
Metatarsal	11	581.0	1903.0	897.0	30.5	46.5	11.2
Phalanx 1	4.1	21.0	–	99.6	33.3	3.7	15.1
Phalanx 2	4.6	16.3	–	77.5	24.8	1.8	11.8
Phalanx 3	1	9.3	–	44.3	13.6	0.9	6.7
Phalanges (set of 3)	2.9	46.7	998.0	221.0	23.9	6.4	33.6
All cervicals	1	2429.0	–	2429.0	14.5	–	277.3
All vertebrae	1	6568.0	–	6568.0	14.1	–	794.4